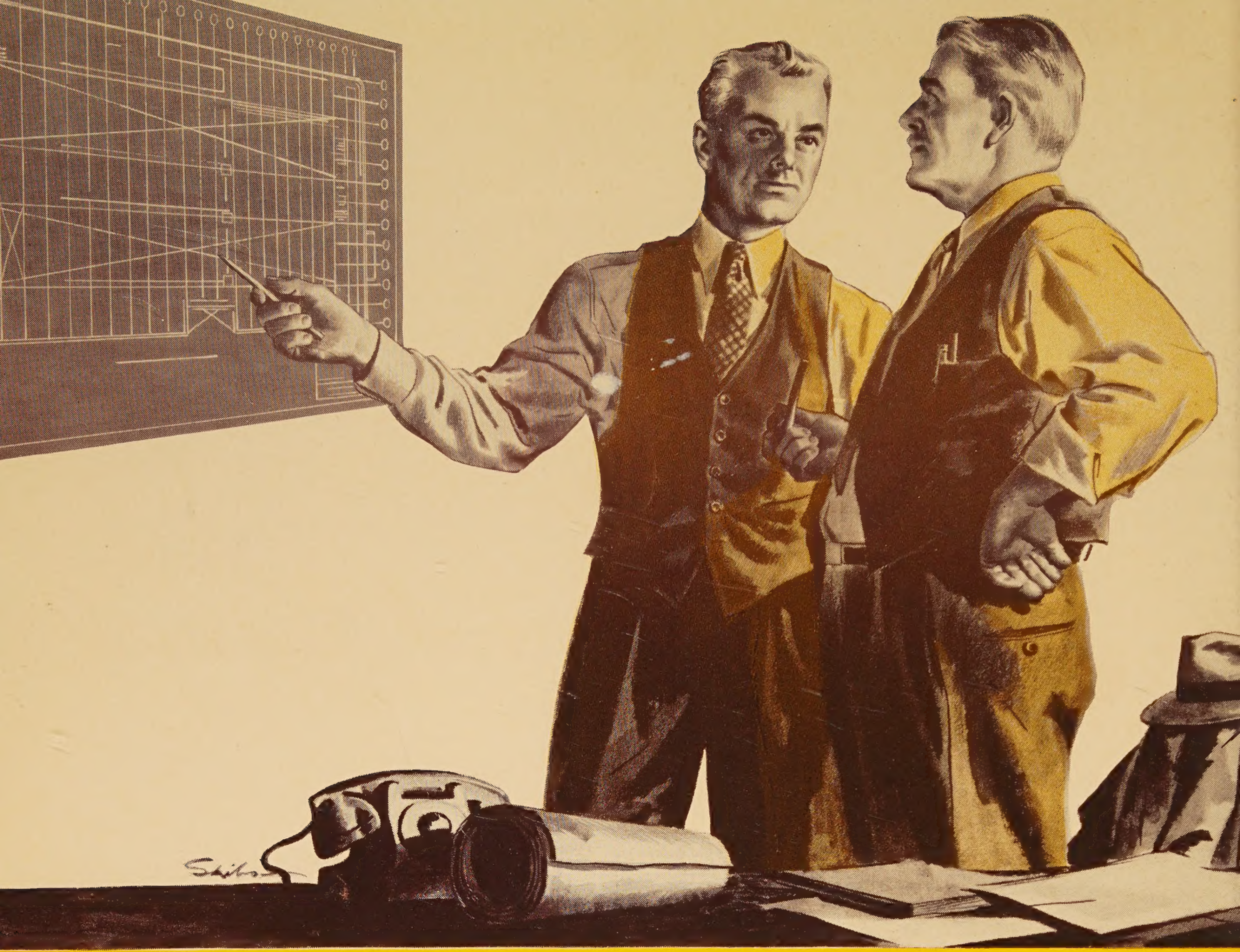
ELECTRICAL ENGINEERING

MARCH 1943

AIEE DISTRICT TECHNICAL MEETING, PITTSFIELD, MASS., APRIL 8–9, 1943



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Registered U. S. Patent Office

MARCH

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The Cover: This cascade of molten particles was created in the General Electric Company's high-voltage laboratory at Pittsfield, Mass., when a 10-foot length of resistance wire was struck by a charge of "man-made" lightning. A meeting of the AIEE North Eastern District will be held in Pittsfield, April 8–9, 1943 (see pages 113–14).

TRANSACTIONS SECTION

(Follows EE page 140; a preprint of pages 107–58 of the 1943 volume)

Statements and opinions given in articles and papers appearing in *Electrical Engineering* are the expressions of contributors, for which the Institute assumes no responsibility. ¶ Correspondence is invited on all controversial matters.

Published Monthly by the

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Founded 1884

VOLUME 62

NUMBER 3

HIGH LIGHTS • •

Ultrashort Electromagnetic Waves. A series of lectures on electromagnetic theory as applied to ultrashort waves, or microwaves, sponsored by the basic science group of the AIEE New York Section, is to be published in *Electrical Engineering*, and if sufficient interest is shown, will eventually appear in combined pamphlet form. The first in the series deals with the concepts of Maxwell's electromagnetic field theory. Starting with the fundamental relations of ordinary circuit theory as a basis, it is shown how the concept of dielectric current leads to propagating waves, which at high frequencies barely penetrate into metallic conductors, being guided rather than carried by them (*pages 103–12*).

Research for War. Government agencies composed of technically trained civilians are carrying on the important task of co-ordinating the work of scientists and engineers in the development of weapons for war in close co-operation with the Army and the Navy. At the recent AIEE national technical meeting, the director of the Office of Scientific Research and Development described the contributions of this and other organizations in furthering research and development on new and better implements required by the armed forces (*pages 96–102*).

Kilowatts and Kilovars. The kilovar requirements of a system in general should be divorced from the kilowatt requirements, and the two factors should be dealt with as independent commodities, if maximum usage of system capacity is to be made in producing kilowatts, says one engineer. Two to six per cent of the system investment is chargeable to the kilovar requirement when supplied near the load by auxiliary kilovar generators, as contrasted to 20–25 per cent when supplied by kilowatt generators in the power station. (*Transactions pages 133–7*).

Load Limits for Conductors. A method of determining the maximum continuous current-carrying capacity of copper conductors in overhead lines is presented, as governed by certain operating limits of temperature and time. Design limits of ampere ratings as determined by this method are reported to be from 10 to 35 per cent higher for bare conductors and from 10 to 20 per cent higher for covered conductors than those previously used on one system (*Transactions pages 148–52*).

Intrasystem Transmission Losses. One method of calculating transmission losses within power systems consists in deriving a special loss formula for a given system which is suitable for any condition of generation, load, and interchange, and may be used for determination of losses, or for billing, forecasting, or system planning. Results achieved with this method check well with a-c calculating-board studies and with longhand calculations of intrasystem losses (*Transactions pages 153–8*).

Pulling Loads on Lead-Encased Cable. Results of an investigation of the pulling of lead-encased cable in underground systems show evidence of disturbance of the mechanical uniformity of the insulation that is not detectable from an examination of the lead sheath. A method of judging the possibility of damage to the cable through stretching the cable sheath excessively is suggested (*Transactions pages 138–48*).

Transformer Overloading. A method of determining allowable overloads for transformers has been developed which takes into consideration individual transformer characteristics and the specific shape of the overload curve, in addition to other factors. Allowable overloads thus determined are said to be often considerably higher than those indicated by standard AIEE methods (*Transactions pages 126–32*).

Synchronous Motors. Automatic field control of synchronous motors applied to varying loads produces higher operating efficiency, better power-system voltage regulation, and, for certain types of load, when properly co-ordinated with the motor design, substantial saving of critical materials (*Transactions pages 113–19*).

Multiorifice Interrupter. A multiorifice oil-flow interrupting unit now makes it possible to reduce the required number of breaks in high-speed operation of high-voltage oil circuit breakers to the point where even three-cycle 230-kv breakers appear practical with only two interrupting units per pole (*Transactions pages 119–25*).

District Technical Meeting. At the AIEE North Eastern District technical meeting to be held at Pittsfield, Mass., April 8–9, 1943, subjects of interest to electrical engineers in carrying out their professional duties during wartime will be stressed (*pages 113–14*).

Preventive-Maintenance Methods. Fundamentals underlying common maintenance functions applied to electric and Diesel-electric locomotives are reviewed, and the effects of operational abuses are considered, with a view to conserving time, material, and labor for the war effort (*Transactions pages 107–12*).

Technical Training for War. Two of the key men engaged in planning and setting up the Army Specialized Training Program and the Navy College Training Programs discuss the salient features of these plans, as they are being put into operation, at the recent AIEE national technical meeting (*pages 89–95*).

National Technical Meeting. Sessions and conferences of the AIEE national technical meeting held January 25–29, 1943, in New York, N. Y., covered many aspects of wartime engineering and indicated some of the electrical engineer's contributions to the prosecution of the war (*pages 115–16*).

Correction. The last sentence of the caption for the illustration of the 75,000-kva transformer which appeared on page 72 of the February issue, should read: Provision is made for addition of forced-air cooling whereby the rating can be raised to 105,000 kva.

Coming Soon. Among the special articles and technical papers currently in preparation for early publication in *Electrical Engineering* are: the second in the series on ultrahigh-frequency waves, an article on transmission-line theory by J. R. Ragazzini (A' 33); an article on the role of lighting in accident prevention by H. L. Logan (M '28); an analysis by R. D. Evans (F '40) of the operating characteristics of multiphase power rectifiers from the standpoint of harmonics and load balance, their interrelation, and their effects on the apparatus and circuits to which they may be connected; a description of a new winding-insulation testing equipment and method designed to provide adequate turn-to-turn and conductor-to-ground test-voltage stresses, by C. M. Foust (M '31) and N. Rohats (A '36); an exposition by B. M. Jones (F '42) of the problems of transmission extensions made for large electric furnaces, using a minimum of copper, and designed to prevent an adverse effect on the system, particularly the lighting; a discussion of the operation and advantages of a vertical-flow compressed-air circuit breaker and its application on a 132-kv power system, by H. A. Langstaff (M '27) and B. P. Baker (M '41); a résumé by A. J. Petzinger (A '36) and B. E. Lenehan (A '24) of the various methods of charging consumers on the basis of primary or high-voltage energy supply, including the transformer losses, without the expense and difficulty of metering directly on the primary side; a survey of developments in the fields of rural electrification and electro-agricultural engineering since their beginnings, by M. M. Samuels (F '24); a description of the construction, operation, and general specifications of the Auto-Blast interrupter switch, by A. E. Williams, Jr. (M '42) and W. G. Harlow (A '42).

Training Technical Leaders for War

In the accompanying two articles details of the recently formulated Army Specialized Training Program and the Navy College Training Program, which have as their object the education of officers, engineers, and other technical specialists for war service, are discussed by two of the leaders engaged actively in planning and setting up these programs. A joint statement of the Secretary of War and the Secretary of Navy announcing the inception of the training programs appeared in an earlier issue of *Electrical Engineering*.[1]

THE ARMY PROGRAM

HERMAN BEUKEMA

AMERICA'S institutions of higher education are going to play a steadily increasing part in this war effort, in part because of their own initiative; and, to a greater degree, because of the circumstances that compel the War and Navy Departments to engage their facilities for training purposes. The Army Specialized Training Division which we are now setting up operates under policies determined by the War Department; the execution of those policies is left in the hands of our division.

A maximum of 150,000 men in the year 1943 will take the courses now being organized; the great bulk of these men will be drawn from the armed services—men who will have completed 13 weeks of basic training and will come to the colleges as soldiers. There will be exceptions to that rule. There will be some men taking the courses who have not had the 13 weeks of basic training but who will continue their work in the colleges right on to their graduation.

Over and above those 150,000, the War Department is providing for the training of a group of aviation cadets. Our division is assisting the Army Air Forces in selecting the schools. We intend to maintain in the colleges a pool of some 70,000 aviation cadets. Selection of those institutions is based on their ability to provide the desired courses and also on the availability of flying facilities in the near vicinity.

In addition to that, the War Department has for many months maintained a number of so-called "short courses." Until recently all arrangements for them were made with the colleges by the separate arms and services, such as the Signal Corps, the Ordnance Department, and so on. The current total of trainees in such courses, about 36,000, is anticipated to rise to at least 50,000 within the next few months.

In addition, there will be an over-all pool of some 37,000 women "going to war"—the WAAC's. They for the most part will go into co-educational institutions and into women's schools, to receive training that will enable them to replace able-bodied men for combat service.

In order to select our trainees from the armed services and bring them into the schools we have called on experts in selection and classification who will make up screening boards operating in every large camp and station within the continental limits of the United States. We will have traveling boards to cover all of the smaller units. We have set up, after developing a system of yardsticks, the intelligence quotient we consider necessary for men coming into the basic or freshman level of the courses in which we are interested. Part of the evidence to be considered in each case is the transcript of the student's previous academic record. For men who have had college work at the undergraduate level such records are extremely important. In particular, this is the group on which we must rely for our 1943 output.

Our screening boards will be operating continuously. Just as there is a continuous flow of selectees into the camps from all parts of the United States, so there must be a continuous outflow into the colleges if we would avoid the difficulty of having the desired raw material escape us by getting overseas first. In short, if there is a man who needs, we will say, one year more of intensive education in order to be the electrical engineer wanted by the Signal Corps or by Ordnance or by the Air Forces, we want to get him before he gets away. It is obvious that any such system of continuous screening would result in the piling up of a huge backlog of men if we were able to enter them in the colleges only at the regular semester or term openings. To meet that situation, we will provide for a stagger system of college openings. One group of colleges is scheduled to receive their contingents about March 1. A second and larger group will be entered April 1. Thereafter every month will witness the entry of a group. In all schools the quarter system will prevail for our trainees, and no institution

1. *Electrical Engineering*, volume 62, January 1943, pages 37–9.

Essential substance of an address delivered at the general session of the AIEE national technical meeting, New York, N. Y., January 27, 1943.

Herman Beukema is colonel in the United States Army and director of the specialized training division of the Army.

will receive an entering group except at the beginning of a quarter.

The soldier who has had 9 of his 13 weeks' basic training is eligible to take our examinations. There probably will be some men who do not desire preferment of any kind, whether as candidates for the Officer Candidate Schools or the Army Specialized Training courses. Some of those men will of course be highly desirable material but, through some mental quirk they prefer to serve in the ranks. As in World War I, it will be difficult to locate and identify them first of all, and equally difficult to direct their efforts into the special channels that will ensure the full utilization of their special abilities. Obviously it would be wasted time and effort to give special training, including college instruction, to a man whose one ambition is to be tossing hand grenades at the enemy.

When a trainee asks for preferment, he is going to take not only the classification test given at the present time to all candidates for the Officer Candidate Schools, but an additional test which we will superimpose. Each candidate takes the entire set of tests. The board then will determine whether this man should enter an Infantry Officer Candidate School; or, in line with his own wishes and his capability, become a freshman in a premedical course; or again, if he has already had some college work, go on with his training to arrive at the end-point we have established for him.

At this point I wish to comment on certain mistaken impressions that have arisen in the colleges and in the minds of the general public as to the combined purpose and effect of our program. It is in no sense a step toward militarization of the colleges. We are not taking over the colleges. We are not destroying the American system of education or any part of that system. At the same time our program is not planned as a device to preserve the colleges in time of war. The Army Specialized Training Program has been organized to ensure the special development of selected soldiers, men in uniform, to enable them to perform the duties that necessitate such training. Facilities for such training do not exist within the Army. They could be set up in our camps only at enormous cost, involving likewise the use of critical materials urgently needed in other phases of our war effort. The colleges do have the wanted equipment, teaching personnel, and physical plant required. So, to those colleges we will send selected trainees. They will be soldiers in college, not students in uniform.

Some months ago General Somervell stated that, in an army of 4,000,000 he was short by 838,000 the number of specialists needed for certain kinds of duties. He was referring in particular to the men who could operate tanks or tractors or repair and maintain them. But at the same time, he was thinking also of the supervision of that work—of the man who can operate a maintenance depot, let us say, in Eritrea, the man who could be sent into a factory to inspect the production of airplanes. He was thinking of personnel at the officer level as well as of men at the enlisted level. It is our purpose to fill that increasing need and to assure ourselves that we will have a continuous supply of highly trained personnel right to the end of the war.

Let me give you a picture of what is going to happen to a group of 500 men arriving at a given institution which we will call X College. These men, we will say, are classified in two groups. We have contracted with that institution, let us assume, to train electrical engineers and mechanical engineers. Some of these men will have had some college work in those lines; some will come in at the freshman level.

When these men arrive, they will be turned over to the dean and the faculty precisely as that faculty would have received any other body of transferees from other institutions in time of peace. Their records, their intelligence quotients, the results of our tests, plus their transcripts of records from the colleges they have previously attended, will be with them. The dean and the faculty will scrutinize the available evidence before deciding on the term or level at which the trainee is to begin his college work. From that point forward academic instruction of the trainee is in the hands of the college teaching personnel. Military instruction and the supervision of physical training will be under military control. Of course, the physical instruction personnel of the colleges will conduct the work in their special field.

The advancement, the retardation, the setting back, or the screening out of trainees will be done by the college authorities precisely as they have always done it. However, the screening officer who will be a member of each of these college units will participate in this continuous job of testing and classification. In addition to that, we expect—and I believe we can properly expect—that we will get from the college authorities their reports and analyses of these programs, the indications as to where the program can and should be revised in the interest of all concerned.

The bulk of our men will be trained for engineering of one kind or another. A second large group will be prepared in the field of medicine. There will be, in addition, a group in psychology, to provide the classification men, the screening types, that we need in the service. There will be a considerable group in what we call foreign area studies, the men who will become liaison officers in the lower echelons operating between, let us say, a regimental commander in North Africa and the natives of the country. The range of such preparation is amply illustrated by the fact that some 28 "rare" languages are included. Necessarily, each trainee will be developed for service in one or a limited number of areas.

The engineering and premedical courses are uniform at the basic level and continue so up to the end of the second term. The major concentration is necessarily on physics and mathematics, the two majors in the lower stages, but a group of three courses which we consider

vital and important has been added. The most important of these is our course in American history, rather different from those presented in some institutions in the past. It aims to show the trainee that everything did not begin from scratch in the United States—democracy, liberty, the American way—on the 4th of July 1776. From my own experience with cadets entering West Point, I know that the great majority come into the Academy with that mistaken idea.

We know that in many cases these young men may be in Europe for some years to come. There is the opportunity for us to prove to the world that democracy can win not only a war but a peace; that it can do its job of rehabilitating a broken world, without billboards and speeches, but by precept and example. It is important for this reason that these young officers shall realize that the roots of American history are not in this country but took shape in many parts of the Old World over many centuries past. It is important to trace the origin of our social, economic, political, and military institutions to that Old World and see how and where we dovetail, particularly if we are to be the bearers of the torch of democracy to that world.

Side by side with that course is one in geography. It is a new type of geography, in a certain sense, at least, and this is the one place where we will have to write a textbook. The man who helped us to arrive at that decision was Doctor Isaiah Bowman, long since recognized as the dean of American geographers. The course outline, prepared by Professor Derwent Whittlesey of Harvard University, opens with a concentration on the study of physical and political geography, in terms of the globe, and the recently developed projections, rather than the flat map. An interlock with the work in history is established by showing the influence of geography on the course of events in the Revolutionary War, the Civil War, World War I, and World War II. Climate and soil variations in terms of physical principles are given ample attention. The course concludes with an analysis of the factors that combine to make up national and regional combat potential, with major emphasis on the geographical factor.

The third course in the nonscientific group is one in utilitarian English. Beginning with a review of the fundamental principles of rhetoric and grammar, it brings the trainees as early as possible into oral and written composition, including one term of scientific writing. Tying in with history, papers will be graded both for historical content and as exercises in English.

The Army courses will be presented in quarters, periods of 12 weeks each, with a gap of one week between quarters. That gap permits the college to take care of the overhead, gives the hard-worked trainee a breathing spell, and gives us the opportunity to keep things well co-ordinated. Some questions have been raised as to why we adopted the quarter rather than the trimester systems, as followed by the Navy. I can only say that the quarter gives us a far higher degree of flexibility than any other possible arrangement, a factor of great importance in assuring the earliest possible return of these trainees to duty with troops.

In drafting our courses and curricula we called on the American Council on Education for its recommendations as to the best men in the teaching field. They, in turn, sought advice from the Society for the Promotion of Engineering, and similar bodies. As a result we got in each field a panel of the outstanding teachers in the United States. From each such panel we took a group large enough so that it would represent varied views, but small enough to prevent its developing into a debating society. All our curricula are subject to final review by our over-all advisory committee of nine college heads.

C. A. Dykstra, president, University of Wisconsin, Madison, Wis.

R. D. Hetzel, president, The Pennsylvania State College, State College, Pa.

Felix Morley, president, Haverford College, Haverford, Pa.

Guy Stanton Ford, executive secretary, American Historical Association, Washington, D. C.

John J. Tigert, president, University of Florida, Gainesville, Fla.

Ray Lyman Wilbur, chancellor, Stanford University, Stanford University, Calif.

Isaiah Bowman, president, The Johns Hopkins University, Baltimore, Md.

Robert E. Doherty, president, Carnegie Institute of Technology, Pittsburgh, Pa.

Robert I. Gannon, president, Fordham University, New York, N. Y.

As may be seen, that group provides representation from every region of the country, from the little college and the big college, from the technological and the liberal arts institutions.

Under our program, the trainee gets a work-week of 24 or 25 contact hours—class and laboratory. By contact hours, I mean clock hours. He gets 24 to 25 hours of supervised study. We figure one-for-one is a fair rule. In a course in mathematics a man will need $1^1/_2$ to 2 hours for each classroom hour. On the other hand, where he is having laboratory work he may need only $^1/_2$ hour of study. The one-for-one rule seems to meet the situation fairly. In addition to the academic work 5 hours of military training per week will be included. There will be on the average one hour per day of physical training, body building. And we have not forgotten, believe it or not, a small daily period which we call free time, as well as the time from mid-afternoon Saturday until supper time Sunday night. Even with such relaxation, the total work-load is substantial.

To meet this program adequately, we have the trainee up at 6:30 in the morning and in bed at 10:30 at night. There is not going to be time for extracurricular activity. He is going to know he is working under just as intensive a program as his buddies in the camps. He is going to

realize that this has to be done because of the necessities of war, and I have no doubt that the majority of young men of the type we want will respond magnificently.

What are we going to do with this man when he has completed his training? Not all of them will complete it. Some men will go only through the basic phase, the first three quarters. I am speaking now of men who come in at the freshman level. They will have reached the limit of their capacities. That is happening to the civilian student in the colleges every day. The college faculties and our screening personnel, working together, will determine when Cadet John Doe has reached the level of his capacity or perhaps the level of his will to work. If his attainments up to that point are still worthy of note, he will probably be screened out and recommended for duty as a technical non-commissioned officer. If his work is not up to that standard, he simply goes straight back to the ranks. Those who stay on remain as officer candidates.

I would like to discuss very briefly the connection of this program with the whole problem of education. If this is going to be a short war—if Germany, in other words, should miraculously collapse within a few months (always within the realm of possibility)—then, of course, the immediate effect of any such program is going to be minor. It may be no more than a headache to all concerned. But if the program is carried on for any length of time, it has very real possibilities.

Every educational expert who has worked with this program (we have had some 200 now who have come into the work in one way or another) has expressed the view that a great deal of time has been wasted in the past in the colleges. One of our leading college presidents remarked that 50 per cent of the men who normally go to the colleges never should be there; and 50 per cent of those who do not go to college should go there. If we had fully democratized education, I believe it is quite clear that a very large percentage of the youngsters who, for economic reasons cannot go to college under normal conditions, would do eminently fine work if that opportunity were presented. Of course, under our program we are going to pick up a considerable number of people of just that type, youths who have had high school or the equivalent of high school education and have the intelligence to do superior work in college. It is going to be very interesting to see how well they carry on.

If there is any water to be squeezed out of education, water represented by the vast amount of time that in the past has gone into social activities, and into overemphasis on athletics (and I believe very strongly in athletics, including intercollegiate athletics) I believe that this program will ultimately provide the opportunity for a restudy of that entire situation. The years of war and the years of reconstruction ahead of us will hardly produce more tolerance for the loafer in college than for the loafer outside.

More important than that—and this is an idea that comes again from the college presidents—we do feel that the weakest spot in education today is not to be found in the primary grades, nor yet in the colleges, but in the period between, the secondary schools. It is possible today to get in some states a certain kind of diploma which shows only that a student has attended an institution for four years; in other words, he has been exposed to education. He can get a certificate to prove it, one that passes as a diploma. It is likewise possible today to go through high school, taking only the easy courses and emerging with a diploma which is worth very little more than the paper on which it is written.

We encounter in the entrance examinations for West Point year after year hundreds of men who are doomed to failure after going through courses of that kind. Among them are many intelligent youths whose time in the secondary schools has been largely wasted.

The college heads and teachers who have worked with us in shaping the curricula of the Army Specialized Training Program believe it is high time to put back into the high schools the compulsion to make the mind do the job that the mind ought to be doing at that particular stage. Such compulsion can be applied, but not by the armed services; it can be developed, I believe, through pressure which comes down from the colleges and in due time reaches the attention of the State legislatures. The important thing, however, I believe, is to show, first of all, that the necessity for that kind of influence exists. If it does exist, I believe that the response of the American public will be in the right direction; and if so, we will have a chance to correct a condition that has been particularly bad since the great depression of 1930. It was rather heartbreaking, in a way, to watch the progressive decline in the country's educational standards, particularly in certain areas of the United States—areas in which it was difficult to get the tax money needed to keep the school systems running at an efficient level.

Wartime pressure has focused our attention on slackness in production, on slackness in mental as well as physical output. Seeing eye to eye with the colleges on the necessity of making the most of the fleeting, formative years, I believe we can co-operate in helping the leaders in the secondary schools to bring to the college level a student better equipped for higher education than has been the case in the past.

As to what credits our trainees are going to receive for their work under the Army program, I can only say that this is a matter for each college to decide. I speak of course of credits toward the degrees which most of the trainees will be seeking when they return to their studies after the war. Credits necessarily can be given only for sound work in balanced courses maintained at the college level. On that score I am glad to say that all of the many educators who have worked with us are convinced that the Army courses fully meet the desired standard.

If the colleges and the armed services had seen eye to eye on certain important matters between World War I and World War II, if we had been in step through a period vital to America, I do believe that we would have been infinitely better prepared in every way for the things that have happened since Pearl Harbor. I think the ultimate loss in human life and in property would have been greatly reduced if we had worked hand in hand. We were not together. In many respects we were definitely apart. I am not going to try to assess the blame; that is water over the dam. I can only say that in my personal experiences on many campuses from 1930 on I frequently discovered an atmosphere that bode no good for this country in the hour of danger. No one has been more ready to admit the truth than our educators themselves.

We are now standing together in our thinking to a degree that we have not done for a long period of time. Beyond this war I see a period in which we must stand absolutely together, because we have before us a very important joint task, a period of training men for the job of rehabilitation—rehabilitation of this country as well as the devastated areas abroad; a period in which there is going to be a demand beyond our conception for trained men to work in these broken, destroyed countries. Many of you, possibly more than half of you, served in the last war and have vivid memories of destroyed French villages and towns. Those areas, after all, were infinitesimal as compared with what we are going to find in Europe after this war. We are going to find them broken to a degree that is beyond human imagination, broken to an extent where it is going to require tens of thousands of American engineers and other specialists to rehabilitate that section of the world and to give it a viable way of life once more. In all of that we will have to have a broad vision and a common understanding between two agencies: the civilian institutions training civilian young America, the Armed Services with their own educational institutions and the instruments of force which bar the road to the coming of World War III. We have a common destiny, and I am hoping that, in this period of education we now face, we will face it jointly, co-operatively, and working to a common end. We desperately need each other.

THE NAVY PROGRAM

J. W. BARKER
FELLOW AIEE

THERE are three main aspects of this great war problem: The Army, the Navy, and the war industry of this country. No one of those aspects can be forgotten if this tripartite organization is to function efficiently, smoothly, and to the end that we train a team to win this war. Colonel Buekema and I, however, are considering primarily the problem of the Army and Navy, but not for a moment do we, as responsible officers of the armed services, forget the other member of the team. The responsibility for training for war industry is laid upon another agency of the Government, the War Manpower Commission; but it is our responsibility to insure that our programs and whatever program the War Manpower Commission may develop integrate together, and that neither the Army nor the Navy usurp nor contract for nor absorb so much of the training facilities of the country as to prevent the third member of the team from having its proper opportunity to do its job. I should like to state that positively and affirmatively as the policy attitude of both the War and Navy Departments.

We have a definite job to do. Our responsibility is to train the personnel necessary to be the officers, the leaders of your sons and my sons, whom the Government takes into its service in time of war. How we do that job of training these potential officers is going to determine largely the experiences that our sons go through during their service in the armed forces.

That is in itself a very great responsibility. There stands upon the wall across from my desk in the Navy Department a little sign that expresses to me every moment I lift my eyes from the papers on my desk the feeling that permeates me. It says: "Let no boy's ghost say, 'If your damned training program had only done its job!' "

We are dealing with the lives of young men of this country when we are considering and building these training programs, and we must never forget it.

The program of the Navy is very similar to that of the Army, and I am going to indicate only the minor points of difference. One item of difference arises through the very nature of the services. The Navy has a much easier job in one aspect than the Army, at least in planning for its training program, for this reason: When our shipbuilding program is decided and the number of yards and ways are built, the potential increase in speed with which those ships can come down the ways is minor in comparison with the variations in speed with which the Army may have to activate its necessary units. In other words, the very fact that it takes a year, or 14 months, or 18 months, or two years, to build a particular kind of ship, and that heaven and hell and high water can't change that very much (it may accelerate it 25 per cent, but there are definite limits to the potential speed up) makes our knowledge of the dates on which we must have these young men ready far more accurate and more readily determinable than is the case in the Army program. Consequently since the beginning of its program in 1939 with a considerable degree of precision, the Navy

Essential substance of an address delivered at the general session of the AIEE national technical meeting, New York, N. Y., January 27, 1943.

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has been able to predict in advance the numbers of men and the dates at which these various levels of men must become trained and ready to assume their places aboard the ships as they are being placed in commission.

On the other hand, our problem in some respects is more complicated than the Army's. I ask you to think for just a second of even the bridge of a destroyer or a cruiser or a battleship or an aircraft carrier today. There is no place in the Navy to which you can turn where the technical man is not the heart and key of the problem. Our training is entirely scientific and technical. The gadgets for even the navigator have become such that he must be almost an electrical engineer to handle that ship on its bridge. Therefore, from that point of view, our program becomes more technical for all the officers or potential officers of the Navy than is true with the Army.

The Navy program with its definitive dates permits us also to reverse the situation that the Army faces. The Army feels, and very properly so, that it must give a certain amount of basic military training to these young men before they go to college. The Navy's point of view is that we can furnish that military training best, most adequately, and most effectively, after they have finished their college program and while that ship is being commissioned in our Reserve Midshipmen's Schools and aboard ship. The content in both programs is the same; the point of view in the time at which these various things are given is the difference.

We propose to open the Navy training program to high-school seniors, or to those of equivalent training and education, either in the high schools or after they have been inducted into the service. We will select them by screening tests just as Colonel Beukema has described and send them to those colleges that have contracted for their facilities with the Navy.

The first two semesters, the equivalent of an academic year, will be essentially uniform. Our programs also have been mapped out by engineering educators who have been with us in Washington, and then they have been discussed with various college faculties. The first two semesters of both Army and Navy training programs practically speaking, are the same; there are minor variations for the premedical students.

At the end of two semesters, the men are screened again, both by the college and by the Navy, to determine whether they are maintaining the academic standards and the record of accomplishment desirable or necessary to justify the expenditure upon them. Those who wish for aviation training will have volunteered during the first two semesters and taken their flight physical examinations. At the end of the first two semesters, if selected, they will be separated from the Navy college training program as such, go directly into a separate curriculum in the preflight schools and then the flight schools, and finally be commissioned as aviators.

A considerable block of the remainder of the men will continue for two more semesters, the equivalent of another college year. At the end of that time, the premedical students, the predental students and the prebusiness supply corps will be separated into groups. Vocational counseling and guidance have gone on during the equivalent of the freshman year; each of the programs in the sophomore year will be slightly different from the others and will prepare the students more specifically. However, there will be a very strong background of mathematics, physics, and science running through all the courses. We shall have among the premedical students a larger number of young men than the medical schools probably will take. Consequently, the number not selected by the medical schools for admission—and the medical schools are going to be the arbiter of that—will still be in the service, and their background of training must be such that they become useful as potential officers in other fields. We propose to continue them in training for a short time to make up the difference between the content of their premedical course and that required for, say, general deck duty. We are concerned with salvageable material in this kind of program, just as we are in many other aspects of our war-production program.

The engineering general men, that is the operating engineers for our ships, will continue for a total of three academic years, the equivalent of six semesters, and will then go to our Reserve Midshipmen Schools and to duty in the fleet. The engineering specialists will take the full program of four academic years. Premedical students, of course, have been separated out and have gone on to the medical schools. The chaplains have also been placed in specialized groups, and the business-school Supply Corps men have gone to business school. This program has been planned thus, with continuous sets of screening to determine in which phase of the program the man should be placed.

As to numbers, the Navy will probably take between 45,000 and 50,000 for the beginning of the freshman year. About 20,000 of those, if they volunteer and pass the flight physical examinations, will be separated out for aviation duty and will leave the college training program to go to the aviation training program—the preflight schools, which are to be conducted in the colleges of the country.

The number that will emerge as engineering specialists at the far end probably will be about 6,000 or 7,000.

Let's look at the plan from the viewpoint of the engineering schools of the country. If the Navy has between 6,000 and 7,000 men in this program (the Army will have a number not far from the same), and it takes a full four years to train engineering specialists, and yet we are to leave open facilities for the training-for-industry program which the Manpower Commission must set up, it is going to pose a serious problem for the engineering schools of this country. Taken by and large, their capacity under the normal setup has been about 12,000 graduates a year.

However, there appears to be a natural solution to the problem. Under the proposed method for selecting these young men, the economic status of the man's family has nothing to do with whether he goes to college or not. The young man becomes an apprentice seaman in the Navy, has his tuition paid for him, receives his quarters, rations, and $50 a month pay. Any boy who has the brains can go to college under that program—within the number that the Army and Navy are willing to accept. A similar condition applies in the Army, where a young man becomes a private seventh grade, the equivalent rank to apprentice seaman.

The intellectual level of the young men entering upon these training programs should be higher than the general intellectual level that has prevailed in our colleges in the past, since intellectual ability is the only criterion that either the Army or the Navy is concerned with: the ability to carry the courses of instruction of this education.

Every college educator knows the percentage of his young men who either have to leave college, directly because of financial difficulties, or flunk out because they have to devote so much time to earning their way that they have not sufficient time to spend on their studies to give their intellectual ability a chance to demonstrate itself. With every aspect of financial worry removed, we will have a different situation.

Since a great number of boys normally have had to leave college because of finances, directly or indirectly, the percentage attrition of these young men entering in the freshman year on our program ought to be materially lower than the normal experience factor of the engineering colleges for the last 20 years. In the engineering schools throughout the United States, only 30 to 40 per cent of those entering graduate with their class. This is a high attrition. Consequently, the engineering colleges have had to set aside their facilities for a very large freshman class, only 60 per cent of whom reached the sophomore class, 50 per cent the junior class, and, finally, only 40 per cent the senior class. Hence, these colleges should have facilities available which can be readjusted to a program where the attrition factor will be materially lower. Therefore, when we talk about the Army and the Navy each taking 6,000 graduates a year into their special engineering program, it means that about 25 per cent of the facilities of the engineering schools should be left for the training of men for industry by the Manpower Commission.

It is debatable, of course, whether 25 per cent is an adequate number for industry. It has not been determined yet just how many young men industry is going to need during this period, nor how many can be spared to industry out of the total of those reaching 18 each year, if we are going to fight this war successfully. These are very definite problems of relationships between the Air Forces and their need for men, the Army and its need for men, our Navy, and the training for war industry. These needs must be brought intermeshing and not clashing head on.

To get that intermeshing, however, requires a co-operative attack on the problem. No one group can dominate the situation. As Colonel Beukema said, our hope is that through this program the educational institutions and the armed services will learn to work together co-operatively.

Westinghouse photo

Research and the War Effort

VANNEVAR BUSH
FELLOW AIEE

The relationship between scientists, engineers, and the armed services in the development, production, and use of weapons is of great importance in meeting the exigencies of war, says the director of the Office of Scientific Research and Development, an agency charged with co-ordinating the efforts of technical men to evolve instruments of war in collaboration with the Army and Navy. The interrelated work of this and other agencies, which are concerned with development rather than procurement, is contributing toward filling the vast need of the armed services for the adaptation of war implements to changing conditions.

TO a democracy, nothing is more important in the conduct of a war than the working out of smooth relationships between civilian organizations and military organizations in all aspects of the war effort. I wish that I might go into this broad subject at length, but in this discussion I must confine myself to one phase of the matter, namely, the relationship between scientists and engineers and the military services in connection with the development, production, and use of weapons.

No one can read the accounts coming back from the battle fronts without recognizing that it matters a great deal what sort of weapons we are using and what skill we employ in their disposition. It is not sufficient to be possessed of good weapons; it is essential to be possessed of weapons that are better than those in the hands of the enemy and to use them with greater skill. The attainment of this objective involves the closest sort of collaboration between military men on one hand and civilian scientists and engineers on the other, and it is a part of this relationship that I propose to trace. It is well, I feel, that we should study carefully into this relationship, not only because it is essential to our effectiveness in this war, but also because I hope and trust that the lessons we are learning currently will not be forgotten when we again return to peace.

CIVILIAN COLLABORATION WITH ARMY AND NAVY

One of the advantages of a democracy is that when it is engaged in a war, no one feels that everything should be controlled by the military. There are great areas where civilian organizations can operate to better advantage, and this is and has been our accepted policy. The joints may creak at times, and there is bound to be confusion simply in view of the enormous magnitude of the job involved, but in general we get along faster when civilian organization produces the weapons with which the Army and Navy fight. The same advantages may be cited for civilian research and development, collaborating closely with the armed services, and meeting their needs as far as is physically possible, but acting with that flexibility and freedom which come from independent organization.

I believe, and I know that I am joined in this belief by most of the men with whom I have worked closely in the past three years, that we have gotten on more rapidly and more effectively during this present war in the development and introduction of new weapons under the form of organization whereby civilian groups supplement the work of the Army and Navy than we would have had the entire affair been closely under military control. There are many reasons for this. One of them is the fact that the Army and Navy are exceedingly busy with the immediate. It would be difficult indeed for a military organization to provide adequately for the long range view while at the same time carrying its enormous responsibilities in regard to the battle which may come in the next few months.

I feel sure that new and valuable ideas are much more likely to come to fruition if they can develop their formative stages among groups of independent scientists and engineers before being subjected to the rigors of military association. We are engaged with skillful and resourceful enemies, and we should not at any point underestimate them. Germany in particular has too long a history of scientific and technical accomplishment for us to be tempted to underrate its possibilities in applying its skill to the conduct of war; and Germany has been fully engaged in the development of war techniques for a much longer time than have the democracies. Nevertheless, I believe that the present rigid military regime in Germany is at a disadvantage, when it comes to the development of really new ideas, as compared with the United States, with its ingenuity and resources; and I believe that is especially true in view of the fact that the organization under which we operate gives full rein to the independent efforts of some of the finest scientists and engineers that the country has produced, under conditions in which they can work substantially in their own way and in accordance with their chosen methods, but toward a common end.

An address delivered at the "get-together" dinner of the AIEE national technical meeting, New York, N. Y. January 26, 1943.

Vannevar Bush is director of the Office of Scientific Research and Development, and president of Carnegie Institution of Washington (D. C.).

But a democracy in wartime has certain handicaps also. Unfortunately, from one point of view, our own country has a striking difficulty in adapting itself to modern war which is not generally realized. We are a people who think in terms of mass production. This is excellent, and it constitutes one of our greatest factors of strength. It has, however, the distinct liability that we are likely to think in terms of freezing of designs and production of great masses of standardized equipment, and we think much less readily in terms of a rapidly changing technical situation. In modern war it is a serious thing to be inflexible in this regard.

The weapons that are being used are continually changing. Some years ago I used to meet military men who took the point of view that once war was entered upon the fighting would have to be done by utilizing the instrumentalities available at the beginning of the conflict. I have not heard this view expressed for quite a long while now. Every phase of warfare is changing and is changing radically, and the change is coming about primarily because the methods used are vastly different. The central problem, therefore, in the effective conduct of the war from this standpoint is to be sure that our weapons are thoroughly up to date. This involves a long chain of endeavor, beginning with scientific research and engineering development, and proceeding through tests, procurement, installation, and the training of personnel, to the final use in combat. If any one of these steps is not thoroughly and carefully taken, the end result will not be sufficient.

But the process must be swift also, and mass mindedness is a dangerous state for us unless we also keenly realize its dangers.

Under ordinary peacetime circumstances the progress from a brand new idea to its use in quantity by the public occupies at least five years. There has to be research, development, and engineering design. There has to be design for production and user experience obtained under carefully controlled conditions. Out of this can come a well-engineered device adapted for production in quantity to meet a mass need in an economic manner. Under ordinary peacetime conditions a company that is introducing a new product will short-circuit this proper and deliberate method at its peril, for large indeed are the penalties of plunging into quantity production before all of the loose ends are tucked in. Yet in time of war we are faced with the dilemma of shortening this process or else being dangerously behind the times. Under the stress of war it is possible to compress the time scale somewhat. If it is compressed too much and proper engineering is not accomplished, the results may be very sad. On the other hand, delay in getting new devices into operation in time may have consequences that are disastrous. The attainment of a proper balance in this regard is one of the most difficult problems confronting the industry that produces the devices and the military groups that utilize them. I feel that on the whole we have done a remarkable job of attaining a just balance, but I do wish to emphasize strongly that the matter can never receive too much consideration and attention in a country such as ours, where all our normal peacetime habits lie along the lines of standardization and large-scale production.

FORMATION AND FUNCTION OF THE OSRD

In the progress of a new weapon, from the first idea, to the final use, engineers and scientific men of professional grade enter at many points. Notably they appear as a part of the personnel of the armed services themselves, and they appear also in industry in the manufacture of equipment, and also in those services which are auxiliary to manufacturing effort, but none the less essential if the whole scheme is to function adequately. I shall not attempt to trace all aspects of this matter by any means. I feel, however, that it will be worth while to trace the phase that is concerned primarily with the development of the new weapon from the standpoint of the governmental organization which has been charged with this responsibility in this present war.

It is now nearly three years since the scientists and engineers of this country were organized under governmental auspices for the development of new weapons. In June 1940 there was formed the National Defense Research Committee, charged by the President with the duty of research and development on new weapons and instruments of war. The initial organization was relatively small, but it has grown to a considerable scale. In June 1941 a reorganization occurred and the Office of Scientific Research and Development was formed by executive order. The OSRD was given the broad task of co-ordinating the efforts of scientists and technical men in connection with many phases of the war effort, but it was also given the definite charge of pursuing aggressively the work that had already been started by the NDRC; and for this purpose NDRC was incorporated into its organization. At the same time OSRD also was charged with the carrying on of medical research which is closely associated with the prosecution of the war, and it does so through the efforts of the Committee on Medical Research which is a part of its organization. The entire history of this medical effort is well worth the telling.

At the present time the OSRD is making expenditures at the rate of about $100,000,000 a year. In terms of the over-all war cost this is not a large amount of money. It is, however, a substantial sum when considered in terms of research and development. The OSRD operates entirely by contracts with existing academic institutions, industrial organizations, and government agencies. This method is designed to utilize to the utmost available facilities and personnel and to avoid, as far as it can be accomplished, the construction of great new laboratories. About 2,000 contracts for the carrying on of research have now been entered into and of these about

1,400 are currently active. Approximately 200 industrial laboratories and 100 colleges and universities are at work on OSRD projects, and the number of men involved of professional grade is in the neighborhood of 6,000. These men have assistants of various types.

The way in which the organization functions will, I think, be of interest. There is the closest sort of interrelationship with the Army and Navy at all levels. The NDRC is broken down into 18 major divisions concerned with various phases of war research, and in many cases these in turn are subdivided into sections. Each section is composed of scientists and engineers who are specialists on some phase of the enormous range of war instruments. Working closely with them are officers from the Army and Navy who are also specialists in the field concerned, but who bring in addition the war experience and the contact with tactical reasoning which is essential for sound planning.

The research projects arise in these sections, usually by reason of round-the-table discussion of the current situation and the needs for improvement. Out of such discussions comes usually a definite request from either the Army or the Navy that the OSRD undertake a development along a certain line. The section is charged with the duty of finding the best laboratory for the conduct of the work and the best personnel to carry it on. After these considerations have been met, the section then recommends a contract for the accomplishment of the work. This recommendation is reviewed by the NDRC, and if the committee approves, it passes the recommendation together with its endorsement to the director, who authorizes the work to proceed.

The NDRC examines the operations of divisions through the medium of small subcommittees, and by bringing before it the chiefs of the several divisions.

The manner in which the NDRC operates in this connection is of great importance since it is the central reviewing agency which ties together the entire program. Doctor James Conant, president of Harvard University, Boston, Mass., is the chairman of NDRC, and its members are as follows:

Doctor Roger Adams, head of the department of chemistry of the University of Illinois, Urbana; Doctor Karl T. Compton, president of the Massachusetts Institute of Technology, Cambridge, Mass.; Doctor Frank B. Jewett, president of the National Academy of Sciences; Doctor Richard C. Tolman, dean of the graduate school of the California Institute of Technology, Pasadena.

These are the men who primarily represent American science and engineering. The Honorable Conway P. Coe, commissioner of patents, is also a member and brings to the committee his wide knowledge of inventions and their appropriate handling. The Army is represented by Major General C. C. Williams, whose office in the Services of Supply is in touch with developmental work throughout the Army, and is also in touch with the needs of the Army. Captain Lybrand P. Smith represents the Navy Department, where he serves in the Office of the Co-ordinator of Research and Development.

Once a project has been authorized, the office of the chairman of NDRC is charged with the duty of administering the project from its scientific and technical standpoint. For this purpose the line of authority flows from the director, through the chairman of NDRC, to the divisions, and members of these divisions become the authorized representatives of the office in the guidance of the contractors in their scientific and technical research, in order that their efforts may be directed along the lines that have been approved by NDRC as best adapted to the needs of the services. In this way also adequate reports of progress are made available promptly to the interested parties in the services.

Since the OSRD is concerned with many broad aspects of the relationship between the military services and the civilian organizations, the director of OSRD also has the benefit of an advisory council, which is representative of many points of view. The council comprises:

Harvey H. Bundy, special assistant to the secretary of war; Rear Admiral J. A. Furer, co-ordinator of research and development of the Navy; Doctor James Conant, representing the NDRC; Doctor A. Newton Richards, chairman of the Committee on Medical Research; and Doctor J. C. Hunsaker, chairman of the National Advisory Committee for Aeronautics.

It has also recently included in its discussions Doctor Harvey N. Davis, director of the Office of Production Research and Development of the War Production Board. By special direction of the President, the director of OSRD has the benefit also of the advice of the president of the National Academy of Sciences, who joins in many council deliberations. All of these various organizations will be mentioned later, for their interrelation in the technical phases of the war effort is of much importance.

To continue, however, with the actual functioning of the OSRD, I wish to mention several other phases of its activities and some of the problems that it has faced. The business affairs, concerned with contracts and the like, are handled by the executive secretary of OSRD, Doctor Irvin Stewart, who also conducts relations with other governmental agencies on financial and legal matters.

It has been a task of no small magnitude to fit the OSRD into the framework of the government, so it could operate in a smooth and effective fashion. The office is a part of the Office for Emergency Management, which is in the executive office of the President. The OSRD has attempted, and I believe with extraordinary success, to carry on its affairs strictly within the framework as laid down by Congress, and in accordance with the regulations for the conduct of government business with which these various agencies are charged.

Throughout the rapid growth of OSRD it has had exceedingly effective support from all of the agencies with which it has necessarily come into contact, notably with the Bureau of the Budget, the General Accounting Office,

the Civil Service Commission, and many other groups with which it is concerned as an independent agency within the executive office of the President. It is a pleasure to report that in two and one-half years of experience as the head of a new and vigorous government agency, I have never met with anything but the most helpful attitude on the part of the agencies with which I have been called upon to deal, and with the committees of Congress that have had to do with the affairs of the office. This has been in no small degree due to the excellent support of the executive secretary and his office.

The organization includes also a liaison office, reporting to the director, and charged primarily with the duty of conducting appropriate technical interchange with the allies of the United States. Under specific instructions from the President, there was instituted very early a close interchange with the British on technical matters, and this relationship has continued in a cordial and effective manner. I feel sure that this interchange has expedited the work of scientists and technical men in England in their magnificent efforts for the protection of the British Isles, and I am sure that it has benefitted the United States in its war effort. The liaison office, under Doctor Caryl P. Haskins, maintains a London office through which there are contacts with the British Government at all times.

The close interrelationship of science and engineering is essential in the early aspects of the development of a new weapon. The divisions of NDRC accordingly are made up of men chosen from both fields, working closely in collaboration. Incidentally, these men are selected both from universities and from industry, from large colleges and small colleges, and from private laboratories, and they are drawn from all over the country. Many of them serve without remuneration on a part-time basis; others are on the government payroll, while on leave of absence from their organizations. They serve in every case, of course, as individuals, and they are chosen for their individual qualifications.

In the introduction of a war weapon into use there is, however, a special problem which is unique and which is not encountered in the same form by industry in the course of its development of new devices. During the course of the introduction of a new weapon it passes from the hands of OSRD directly into the hands of the armed services. OSRD is charged with the research and development, but it is not charged with procurement and use, which are in the hands of the armed services themselves. The armed services themselves directly and through contract carry on a great deal of research and development, and many of their new devices come through this channel. This again I will mention later. However, at the present time I wish to trace the handling of the problem which occurs by reason of the transition of devices from the laboratory into the hands of the military. In order to co-ordinate this aspect of its work, NDRC maintains two special pieces of organization. One is what is called an engineering panel, made up of engineers who are at the same time members of the various divisions, together with certain other engineers chosen for their over-all grasp. This panel is charged with the duty of seeing to it that appropriate engineering skill is made available to the divisions and sections in an effective way at such time as a new device approaches the period in its development where it begins to be adopted for actual production and use.

The other special piece of organization is the so-called transition office, which is charged with the responsibility of following the progress of devices, in order to make certain that the problem of scarce and strategic materials is considered in sufficient time. The transition office also arranges with the armed services for initial production in order to carry the device through the transitional phase, in which it has emerged from the laboratory but has not yet appeared in quantity. At this point there is usually involved the production of a sufficient number of pieces of equipment, often produced by hand methods, for purposes of extended tests in the field. There is involved also the selection and indoctrination of an appropriate manufacturer.

CONFIDENTIAL WORK OF THE OSRD

In order to appreciate the way in which the OSRD operates, it is necessary to realize that practically everything it does is highly secret, and that it is not possible to carry on its work under conditions of great secrecy with the same dispatch which is possible when no such conditions obtain. For reasons of security, appointment of personnel in any capacity throughout the organization is made only after careful investigation. A ruling principle, and one which is observed by the Army and the Navy, is that secret matters are held carefully in compartments. This means that no member of the organization will learn of secret matters except to the extent that is necessary for his appropriate functioning in the particular position which he occupies in the organization. Knowledge concerning especially secret matters is restricted to decidedly small groups within OSRD and within the services themselves.

This leads me to mention one other matter. Ever since this organization was formed, I have encountered the question many times as to why it needs to be organized on a national and vertical basis in accordance with subject matter, and why it cannot be decentralized geographically to obtain the benefit of the many individuals in the country who are highly capable in technical ways, but who must necessarily operate on matters of the war effort in their own localities. The necessity for secrecy and compartmentalization is the reason. In many cities in this country, it would be quite possible to form very strong technical and scientific groups locally, composed of men who would put in part of their time, in the evenings and on week ends, on technical matters connected with the war. These groups could represent

many sciences and many types of engineering, and they would be made up of decidedly effective individuals. However, this scheme is not compatible with necessary restrictions on the work of OSRD. It would hardly be possible to assign one subject to each group in a locality. Neither would it be possible to give to such a group the knowledge of the entire range of the development of weapons which would be essential in order to use effectively the diverse characteristics such a group would have. Hence we have felt reluctantly that such groups could not be utilized in the affairs of OSRD. I do feel, however, that they could have real value in other connections, where the conditions of secrecy are not nearly so stringent, and this possibility is being explored.

On the other hand, while OSRD is organized nationally, drawing its membership from all over the country, its sections are made up of men especially adapted for the problems before them and these men are given full knowledge of the technical and tactical phases of the particular weapons with which they deal. They are kept closely in touch with the progress being made in introducing weapons of this particular type in practice, and they form teams which are able to enlist the services of large numbers of men in many universities and industries for the accomplishment of their purposes. All this is done in such a manner as to keep the secret information as closely confined as is consistent with rapid progress.

As previously mentioned, not all of the research and development on weapons in this country is carried on by OSRD. It is the duty of OSRD to relieve the armed services as far as possible in this regard, and indeed as the war proceeds and as the officers in the services become more and more burdened with immediate matters concerning the conduct of the war, the load in regard to research and development has shifted quite naturally, so that OSRD is carrying a greater share of the burden. However, both armed services maintain large laboratories in peace and in war for the development of weapons, and they also further development by direct contract with industry.

The mention of this matter gives me an opportunity to state definitely a fact on which I think there is a great deal of misunderstanding. It has been publicly known for a long time now that when Germany started its all-out air attack on Britain in the summer of 1940, the attack was repelled not only on account of the magnificent equipment and fighting qualities of the Royal Air Force, but also because the British had and effectively used certain radio-warning devices which took the surprise out of the Germans' attacks and assured that their bombers were promptly met by fighter squadrons. It is also known that the British had this device because of the effective work of a group of British scientists and engineers over a considerable period of time. I am also very glad to be able to state that at the same time the Army and Navy of the United States had equally effective devices for this purpose, well developed and in hand. This had been accomplished during years of peace, in spite of the fact that the United States had failed to support its military departments to an extent which rendered research and development in peacetime possible on anywhere near an adequate scale. In particular, I know personally of the early work in this field by a small group of keen naval officers, and there were undoubtedly other groups at work elsewhere. I am looking forward to the day when due tribute can be paid to those officers who very early saw the possibilities of devices of this sort and worked assiduously to the end that they might be practically available. I also wish to emphasize strongly that this work was done long before Europe went to war, still longer before there was any such thing as NDRC. Certainly since its advent, NDRC has worked along these same lines. It has been proud to collaborate with the Army and Navy in so doing, and to work in partnership for the further development of devices on which they had already pioneered, and to share in all of the various possibilities flowing out of that early work. The full story of this development, when it can be told, will involve many scientists and engineers, and its roots go far back for many years. At the present time we are altogether too busy to think much about credit.

RECEPTIVITY TO CHANGE

This leads me to a statement that I have pondered for some time. I am occasionally met by the old accusation that military men are hidebound and reactionary, and that they are generally resistant to the introduction of new ideas. As applied to the present Army of the United States, such a statement is of course absurd on its face, since 24 out of 25 officers in the present Army were in civilian life only a short time ago, and the community of officers in the Army is therefore nearly a cross section of the general public. However, the statement is made usually with respect to the regular officers of the Army and Navy, men who have made military matters their profession.

I have been working very closely indeed with a large number of those officers for three years now. Prior to that time I had had long association with the engineers in the United States, with college faculties, and with businessmen. In every one of these groups, I have met individuals whose receptivity to new ideas was absolutely zero. I shall not single out any particular group for comment, but in every one of these great sections of our population in this country I have been struck at times by an unwillingness to recognize the changing nature of the technical world to an extent that annoyed me exceedingly. I have seen it among college teachers and in groups of engineers, and I have certainly seen it among businessmen. I have also seen the same thing among military officers.

I say to you categorically, however, and I think I am in a position to know, that the men who lead the Army and Navy of the United States in this fight are no less

open to new ideas than is the general public of the United States; and if we as a country are overconservative and disinclined to try new things, then I do not know what the words mean. True, the officers who have seen service are hard-boiled. They have a keen appreciation of what will and will not work—at sea under difficult conditions and various types of weather, on land in the dust and mud of battle. They are intensely practical men, and at the present time they are exceedingly busy men, but they are not reactionary. In two and one-half years of close association with them in the development of new weapons, I have as yet to see the instance where an idea or a device which has come to the attention of the OSRD and which in my opinion had outstanding merit was turned down arbitrarily and blocked permanently by any military officer or any group of military officers. The merit of new ideas has to be proved. Ideas have to go through their growing periods and meet their stresses. This has to occur in business in time of peace and in military affairs in time of war, but the atmosphere is no more hostile in one case than it is in the other.

OTHER DEVELOPMENT AGENCIES

But to return to civilian organizations, there are several aspects of the development of new weapons which very definitely do not come under the control of OSRD, although the council of OSRD functions in an advisory capacity in order to provide a unitary approach to problems of common interest and to prevent overlap and duplication.

Notable in this connection is the National Advisory Committee for Aeronautics. I do not need to trace the position of this organization, as it has been done elsewhere. Founded by Congress over 25 years ago, it has a long and notable record of accomplishment. Inasmuch as the problems of flight are being attacked adequately by the NACA, they are not again attacked by the NDRC, although the latter often carries on work on military devices which become incorporated in airplanes. It is a fortunate thing for the United States that it has had for many years an active research organization in the field of aeronautics. It has worked in close collaboration with the Army and Navy and with industry. A short time ago there was a great deal of discussion as to whether American airplanes were comparable with those of the enemy. Since the records have been coming in from England, Africa, and the South Pacific, this discussion seems to have become resolved.

Because of the interaction of many factors, but particularly because of the fact that we have long had an active independent research organization, working on a basis of excellent interchange with the Army and Navy, and supplying the fundamental basis for the advance design of aircraft, this country has not lagged in the subject, and its position at the present time can best be understood by reading the recent comments of General Arnold, commanding general of the Army Air Forces.

The ideas that finally become incorporated in new military devices originate in a great variety of ways. Many of them come directly from officers of the armed services, and this is increasingly true, as our combat indicates to officers at the front the needs and opportunities. Some ideas come from the scientific and military groups assembled as sections of NDRC as a result of their conferences and discussions. A large number are submitted by the general public. These require a great deal of review, for the percentage of valuable suggestions coming in this spontaneous way will always be small. This review is provided by the National Inventors Council, located in the Department of Commerce. Again, I do not need to review the manner in which this organization operates in order to bring to bear on suggestions from the public the judgment of competent scientists and engineers, and to forward to the armed services for their review the interesting ideas that emerge. There are, however, one or two points in regard to their work upon which I feel it is well to elaborate.

It should be emphasized that the NIC is the official reviewing agency, and that its function is fully performed when it has brought a valuable suggestion to the appropriate attention in the armed services. At the same time it is essential to emphasize that the OSRD does not have the duty of reviewing suggestions submitted by the general public. When the armed services find that an idea warrants development, they may turn to the OSRD in order to have such development performed. Research and development are the functions of OSRD, and it attempts to stay strictly within those bounds. However, the sections that are making plans for the development of new weapons receive many ideas from the members of the group itself, from engineers and scientific men working with contractors who are carrying out research under the supervision of the section, from the officers and men of the armed services, and through the armed services from the Inventors Council.

Unfortunately, the independent inventor is at a very considerable disadvantage when it comes to the matter of making valuable suggestions in connection with military devices. In the nature of things, he cannot be told the entire state of the art to which he is attempting to contribute, so that he works very largely in the dark. This is unfortunate, for the same reasoning is unduly gone through over and over, but it is inevitable in view of the necessity for security. When a man who has placed a great deal of effort on the development of an idea finally submits it, he would like to know whether his idea is new, whether it is considered valuable, and especially, he would like to know if it is being used. Yet in general he cannot be told; in fact, he cannot be told unless he occupies a position in which he is entitled to secret and confidential information in the field of this inquiry. If this principle were not strictly adhered to, the enemy might find out a great deal by simply putting in sugges-

tions and thus learning the general state of the art and the status of development of various military weapons.

I mention this because I believe there has been a great deal of misunderstanding on the matter, and many individuals in the United States have become distinctly annoyed because they were not told of the outcome of review when they made suggestions. It is strange that this situation is not more fully appreciated than it is at the present time. As an example, there was recently published in a prominent magazine an article which described in detail a military device which had been submitted to the armed services, and the article complained bitterly that no serious attention was paid to the suggestion. As a matter of fact, the inventor in this particular instance had visited me personally and described his device. At the time he described it to me, I knew that a better device than the one he suggested was already in use. This I could not tell him. Of course, if his suggestion really had been new and highly valuable, the publication of it with full details would have been of great service to the enemy.

There is another phase of the work of scientists and engineers on developmental matters which also needs to be mentioned. There are broad problems of substitute and strategic materials, and many technical questions involved in the reorientation of industry to the war effort. The development of substitute materials and substitute processes is of enormous significance as the war proceeds. The task of conducting research and development along these lines is not within the scope of OSRD, the activities of which are directed to the development of new weapons and their methods of utilization. On the other hand, the War Production Board has long been deeply concerned with these very matters. In some of its approaches to the problems of materials it has been strongly supported by the National Research Council with scientific and technical advice. Recently, a new office within the WPB has been formed, called the Office of Production Research and Development, and Doctor Harvey N. Davis, president of Stevens Institute of Technology, Hoboken, N. J., is director of this new office.

Many auxiliary problems arise in connection with the technical and scientific effort, and prominent among these is the problem of trained personnel. Fortunately, we have had for a long time now the Roster of Scientific and Specialized Personnel, conducted under the chairmanship of Doctor Leonard Carmichael, president of Tufts College, and his office is now attached to the War Manpower Commission, where it is rendering excellent service.

The rapid survey of the organizational set-up would not be complete, however, without final mention of the National Academy of Sciences and the National Research Council. The National Academy of Sciences was formed at the time of the Civil War and operates under Congressional charter. It is charged with the broad duty of advising agencies of government with regard to their scientific and technical problems. Doctor Frank B. Jewett, president of the Academy, has recently described in some detail the enormous burden which has been carried by the Academy and Council in the performance of this obligation. The OSRD leans on the Academy and Council for scientific and technical advice on many matters. Notably in the medical and metallurgical fields, the organization of the NRC has provided committees of eminent men who have advised continuously and effectively on programs in these fields.

To one who has not worked closely with the governmental organization for the conduct of research and development in time of war, this rapid survey of the organization may seem to indicate a great deal of complexity. It is true that it is complicated, but research and development are themselves necessarily complex. However, the various aspects of the over-all problem now are provided for adequately by the organizations that are operating in the field, and these are tied together as closely as necessary for co-operation by the council of OSRD. The armed services themselves are concerned with procurement, installation, testing, and use. The review of suggestions, the conduct of research and development in the aeronautical field, in the matter of substitute materials, and directly in the development of new weapons are provided for by appropriate groups.

RESULTS OF RESEARCH AND DEVELOPMENT

But what of results? In wartime the work of the laboratory is meaningless unless it finds its way into the field of action. The most tangible expression of the success of scientific effort in the present war is to be found in the attitudes of the armed services. Both the Secretary of War and the Secretary of the Navy have indicated to me their satisfaction over what joint efforts have accomplished in terms of operations. At the close of the last fiscal year, the War Department pointed out that it had placed orders amounting to approximately $560,000,000 for items developed by one section alone of the NDRC. As a result of a new process for making an important military material developed by another section, the Army placed orders for plant and product amounting to about $270,000,000. In this instance there was an anticipated initial saving of $100,000,000 in plant-construction costs and additional savings of many thousands of dollars a day in operating costs, as compared with previous methods.

These figures are now some months old, and a great deal has happened since then. When the story can be told, it will be dramatic, and it will reflect the vigorous efforts of a great group of men, employing the best of teamwork in the common cause. Until then we cannot talk of results. The evidence accumulates rapidly, however, that the devices being developed by American scientists and engineers will play an important part in bringing the war to successful conclusion in a shorter time than might otherwise have been the case.

Ultrashort Electromagnetic Waves

I—Electromagnetic Theory

ERNST WEBER
FELLOW AIEE

Ultrashort electromagnetic waves are of vital importance at the present time. In keeping with the policy of the Institute to concentrate its efforts on matters closely related to the war effort, the basic science group of the AIEE New York Section is now presenting a series of lectures on this topic. The editor of "Electrical Engineering," believing that this material should be made available to the entire AIEE membership, has asked the lecturers to prepare articles to be published in this journal. This first article lays the groundwork in fundamental theory for the entire series. Succeeding articles, all being prepared by recognized authorities, will cover: (II) transmission-line theory at ultrahigh frequencies; (III) generation; (IV) guided propagation; (V) radiation; (VI) reception. If sufficient interest is shown, a consolidated reprint will be made available after the full series has appeared.

PAUL C. CROMWELL, Chairman, Symposium Committee
(College of Engineering, New York University, New York, N. Y.)

THE more recent developments in the use of ultrashort waves for transmission of electrical communication of the audible or visual type have brought to the fore the incredibly simple basis of all the complex applications, namely Maxwell's field equations. The power of these two equations, relating two basic vector quantities of the electromagnetic field, though published first in 1864, is only now coming into appreciation by larger groups of engineers.

It is attempted here to introduce the concepts which are at the basis of Maxwell's field theory and to show in simple illustrations how one can apply them to understand the specific and sometimes puzzling characteristics of very short electromagnetic waves. In particular, the transmission of energy through open or confined spaces, its localization, and detection are of primary importance. In this sense, the hypothesis of the Poynting vector is probably the most striking addition since the original formulation of the field theory. A greater part of the material presented will relate to this Poynting vector and its astounding implication, that energy is entirely transmitted in dielectric media and only guided, with slight absorption as a tribute for it, by metallic conductors. It will also lead to the only direct link with circuit concepts, namely to the definition of impedance of a field space.

In the presentation, the meter-kilogram-second-coulomb system of units is used throughout. The meter-kilogram-second system of units has already been internationally adopted and needs no further elucidation here. The meter-kilogram-second-coulomb system uses, in addition to the mechanical units of meter, kilogram mass, and second, the coulomb as the fourth unit, linking all the practical electrical units to the meter-kilogram-second system. In this system, the permeability of free space (vacuum) is defined as $\mu_v = 4\pi \times 10^{-7}$ henry per meter, and the dielectric constant of free space follows as $\epsilon_v = 1/c^2\mu_v = 10^{-9}/36\pi$ farad per meter, where c is the velocity of light in free space and taken as 3×10^8 meters per second. Although, as indicated, the meter-kilogram-second-coulomb system will be used throughout, it will frequently be advantageous to replace the meter by the centimeter in order to lead to values that are more readily visualized.

TRANSITION FROM CIRCUIT CONCEPTS TO THE GENERAL FIELD CONCEPT

A current flowing in a conductor of arbitrary cross section produces a magnetic field surrounding it in closed field lines, which can be characterized in a number of different ways, for example, by saying that the line integral of magnetizing force $\boldsymbol{H}$ over any closed path C is equal to the total current penetrating this path,[1] or

$$\oint H_s ds = i \tag{1}$$

As illustrated in Figure 1, H_s is the component in the direction of the path element $\boldsymbol{ds}$, and i is only that part of the total current actually passing through the closed path C. Frequently, the above line integral is called magnetomotive force $\mathfrak{F}$, particularly in connection with the design of magnetic circuits. Then, equation (1) is interpreted as meaning

$$\mathfrak{F} = i = \oint H_s ds \tag{2}$$

or the value of the magnetomotive force is equal to the current value; but this does not mean that the two concepts are identical. In fact, in any compound magnetic circuit, it is not possible to associate with portions of the

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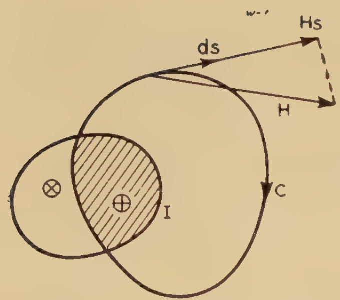

Figure 1. Cross section of conductor carrying current

magnetomotive force certain portions of the total current. Equation (2) is only true for the total quantities, that is, only for the closed line integral of $\boldsymbol{H}$.

If a conductor loop is exposed to a magnetic field varying in time, then, closing the loop will result in a current flow. In analogy to steady flow of current between points of unequal steady potential, one suspects a driving voltage to be the cause, and similarly to equation (2), formulates Faraday's law of induction as

$$V_i = -\frac{d\Phi_m}{dt} \tag{3}$$

where V_i is the so-called "induced voltage," and Φ_m the total magnetic flux penetrating the conductor loop. However, this voltage V_i has never been observed as voltage; it is only active in a closed conductor loop, even if it is only voltmeter leads which complete the circuit. The situation is quite analogous to that presented by relation (2); calling V_i induced electromotive force and defining it naturally as the line integral of the electric field strength E over a closed path

$$V_i = \oint E_s ds \tag{4}$$

we establish rather complete correspondence in the formulation of the two basic relations of electromagnetism for comparatively low frequencies.

Assume now a capacitor as in Figure 2, supplied by an a-c voltage and with practically no resistance. The charging current to the capacitor can be expressed as

$$i = +\frac{dQ}{dt} = +C\frac{dv}{dt} \tag{5}$$

and can be thought of as flowing to the positive plate, building up positive charge and balanced by a flow of negative charge from the negative capacitor plate. It can be identified with the easily observable metallic conduction current. However, between the capacitor plates spans an approximately homogeneous electric field (disregarding all fringing effects) with field gradient $\boldsymbol{E}$ defined by

$$\int_1^2 E_s ds = v \tag{6}$$

and gives rise to a dielectric flux density $\boldsymbol{D} = \epsilon \boldsymbol{E}$, if ϵ is the absolute dielectric constant of the dielectric medium. The total dielectric flux between the capacitor plates must have the same value in all planes parallel to 1 and 2 and the same value as the charge on one plate, namely,

$$\iint D_n dS = Q \tag{7}$$

This relation, known as Gauss' theorem, is merely another way of saying that we measure charge in terms of dielectric flux lines emanating from it. Merging equation (7) with (5) one finds then

$$i = +\frac{d}{dt}\iint D_n dS \tag{8}$$

or also, the metallic conduction current to a capacitor is equal to the time rate of change of the dielectric flux within the capacitor. In other words, within a dielectric medium the time variation of the dielectric flux constitutes the continuation of the metallic current and $d\boldsymbol{D}/dt$ in general must have the significance of a current density. The most immediate experimental evidence would be the observation of a magnetic field within the dielectric of value given by equation (1) if i is replaced by dQ/dt. This experimental corroboration was first given by Hertz[2] but it required very high frequencies, since the current density $d\boldsymbol{D}/dt$ generally is very low but proportional to frequency. Take for air, $E = 10{,}000$ volts per centimeter, $\epsilon = 10^{-11}/36\pi$ farad per centimeter, then the absolute value

$$\left|\frac{dD}{dt}\right| = \omega|D| = \omega\epsilon|E| = 2\pi f\frac{10^{-7}}{36\pi} = 0.556 \times 10^{-8} f \text{ amperes per centimeter}^2$$

One must use, therefore, a frequency of the order of several megacycles per second to obtain easily observable dielectric current densities.

In the case of a capacitor supplied by an a-c voltage and having a finite resistance R, the total current i carried to one plate continues in the capacitor partly as conduction current $i' = \frac{1}{R}v(t)$ and partly as dielectric (or displacement) current $i'' = C\frac{dv(t)}{dt} = \frac{d}{dt}\iint D_n dS$. Within the dielectric, then, a magnetic field exists described by the modified relation (1)

$$\oint H_s ds = i' + \frac{d}{dt}\iint D_n dS \tag{9}$$

where the integral of the dielectric flux has to be extended over the area which is bounded by the closed

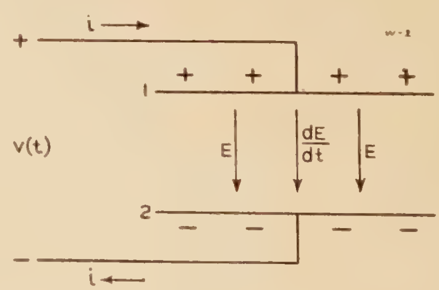

Figure 2. The dielectric current in a capacitor

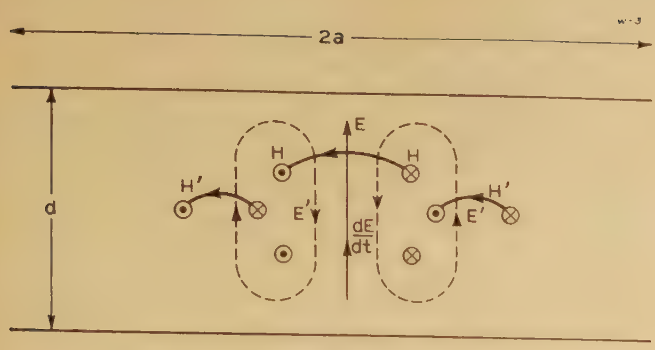

Figure 3. Radiation from capacitor

path C of the line integral. In addition, this time-variable magnetic field induces an electric field, given by the combination of (4) and (3) and suitable substitution

$$\oint E_s ds = -\frac{d}{dt}\int\int B_n dS \tag{10}$$

Here B is the magnetic flux density and the integration has to be taken over the area which is bounded by the closed path of the line integral.

The two equations (9) and (10) are the basic relations of Maxwell's field theory in integral form. Correct applications of these equations to homogeneous stationary media, even at the highest engineering frequencies, have given results checked by experiment to an amazing degree of reliability.

The result of the simultaneous action of both equations (9) and (10) can be illustrated easily in the case of the condenser of Figure 2, redrawn on larger scale in Figure 3. Assume the homogeneous but time-variable electrostatic field E indicated by the center arrow and, for simplicity, assume axial symmetry. If the electric field increases in intensity, dE/dt will be in the direction of E and thus, according to (9), a magnetic field is produced circling around the dielectric current as shown in Figure 3. In turn, this magnetic field varies in time, building up in the same direction, and leads, according to (10), to an induced electric field E' circling around the H. The superposition of this induced field E' results in weakening of the original field in the center and strengthening toward the periphery. Similarly, a new magnetic field H' appears around E', and this process will go on with extreme rapidity, "propagate" toward the periphery, and from there into space as "radiation." If the diameter $2a$ of the capacitor becomes comparable with wave length in the dielectric or even smaller, this capacitor will take on strange attitudes, it will first increase its effective capacitance and then turn into a real coil.[3] Many unpleasant surprises are due to the assertion of the induced dielectric field at high frequencies.

UNIFORM PLANE WAVES IN A PURE DIELECTRIC

Returning to the capacitor field, observe that on account of axial symmetry there is only a vertical electric and a horizontal magnetic field component. For large distances from the center we can disregard the curvature and consider the electromagnetic field as uniform in a plane perpendicular to the two plates, which might be chosen as the y-z plane of a right-handed co-ordinate system shown in Figure 4, that is, we assume no variation along y and z directions. Then, application of relation (9) to a small rectangle along the z-x plane gives with the indicated direction of line integration

$$\oint H_s ds = [(H_z)_1 - (H_z)_1'] \cdot dz = \epsilon\frac{d}{dt}[{}^1/_2(E_y)_1 + {}^1/_2(E_y)_1'] \cdot dx dz$$

Using the first order approximation

$$(H_z)_1' = (H_z)_1 + \left(\frac{\partial H_z}{\partial x}\right)_1 \cdot dx$$

and a similar one for E_y, one obtains

$$-\frac{\partial H_z}{\partial x} = \epsilon\frac{\partial E_y}{\partial t} \tag{11}$$

In the same manner, relation (10) will give, if applied to a small rectangle in the x-y plane

$$+\frac{\partial E_y}{\partial x} = -\mu\frac{\partial H_z}{\partial t} \tag{12}$$

From the integral relations we have now deduced point-by-point differential equations, which show a striking similarity to the transmission line equations, if one disregards all losses,[4] namely

$$\left.\begin{aligned} -\frac{\partial i}{\partial x} &= C\frac{\partial v}{\partial t} \\ +\frac{\partial v}{\partial x} &= -L\frac{\partial i}{\partial t} \end{aligned}\right\} \tag{13}$$

One can now solve the equations (11) and (12) in the same manner as one solves the well-known forms (13). Differentiating (11) with respect to time, t, and (12) with respect to distance, x, one has by elimination of the magnetizing force,

$$\frac{\partial^2 E_y}{\partial x^2} = \epsilon\mu\frac{\partial^2 E_y}{\partial t^2} \tag{14}$$

the basic wave equation in one dimension. One of the simplest solutions is

$$E_y = E_0 \sin \omega(t - x\sqrt{\epsilon\mu}) \tag{15}$$

representing a progressive sine wave in the direction of

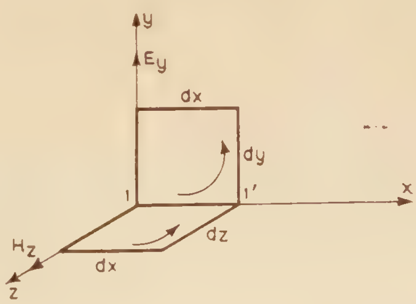

Figure 4. Derivation of differential relations

the positive x axis, a "traveling wave." One defines $\omega(t-x\sqrt{\epsilon\mu})$ usually as the "phase" of the wave; keeping the phase constant, means that the field quantity E_y is constant.

This leads to

$$t-x\sqrt{\epsilon\mu}=\text{const.}$$

or also, by differentiation,

$$dt-\sqrt{\epsilon\mu}dx=0, \qquad \frac{dx}{dt}=\frac{1}{\sqrt{\epsilon\mu}}=v \tag{16}$$

The value v is called the "phase velocity" of the wave; it depends here solely on the electromagnetic constants of the medium and is analogous to the velocity of traveling waves on transmission lines, which have a velocity of $v=1/\sqrt{lc}$; with l the inductance and c the capacitance per unit length of the line. In free space

$$\left.\begin{array}{l}\epsilon=\epsilon_v=10^{-11}/36\pi \text{ farad per centimeter}\\ \mu=\mu_v=4\pi 10^{-9} \text{ henry per centimeter}\end{array}\right\} \begin{array}{l}v=c=3\times 10^{10}\\ \text{centimeters per second}\end{array}$$

Obviously, the variation of E_y has the same character in time and distance. Defining $\omega=2\pi f=2\pi/T$ with T the period, or interval of time periodicity, and $\omega/v=2\pi f/v=2\pi/\lambda$, with λ the wave length, or distance of space periodicity, one can rewrite equation (15)

$$E_y=E_o \sin\left(\frac{2\pi t}{T}-\frac{2\pi x}{\lambda}\right) \tag{17}$$

bringing out clearly both periods. Equation (12) now immediately gives the magnetizing force, since

$$\frac{\partial E_y}{\partial x}=-\frac{T}{\lambda}\frac{\partial E_y}{\partial t}=-\frac{1}{v}\frac{\partial E_y}{\partial t} \tag{17a}$$

and, therefore,

$$H_z=\frac{1}{\mu v}E_y=\sqrt{\frac{\epsilon}{\mu}}E_y=\sqrt{\frac{\epsilon}{\mu}}E_o \sin\left(\frac{2\pi t}{T}-\frac{2\pi x}{\lambda}\right) \tag{18}$$

It is important to observe that this uniform plane wave is a transverse electromagnetic wave, that is, both field

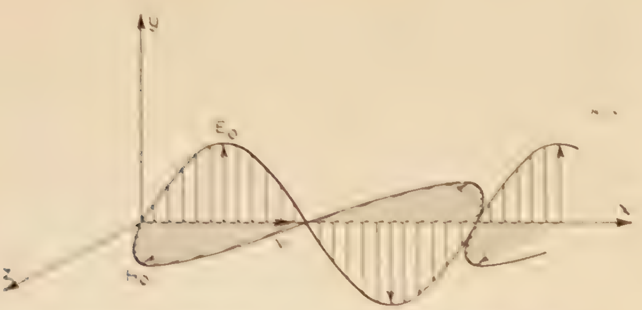

Figure 5. Field distribution in uniform plane wave

vectors oscillate perpendicular to the direction of propagation, as shown in Figure 5. Similar waves, called the "principal" waves, exist in coaxial and parallel wire transmission lines, but not in wave guides! Furthermore, the electric and magnetic field components have exactly the same time and space phase; this can only mean that no losses occur.

The solution (17), (18) is only one of the simplest solutions. An equally simple case obtains with x replaced by $(-x)$, in fact the result is a uniform plane wave traveling in the direction of the negative x axis. Generally, a superposition of both solutions will occur; one representing the "incident" wave, that is, the wave coming from some primary source; the other representing the "reflected" wave, namely, the wave reradiated by any disturbance in the path of the incident wave as a secondary source. Thus one would have

$$E_y=E_o \sin\left(\frac{2\pi t}{T}-\frac{2\pi x}{\lambda}\right)+E_r \sin\left(\frac{2\pi t}{T}+\frac{2\pi x}{\lambda}\right) \tag{19}$$

$$H_z=\sqrt{\frac{\epsilon}{\mu}}E_o \sin\left(\frac{2\pi t}{T}-\frac{2\pi x}{\lambda}\right)-\sqrt{\frac{\epsilon}{\mu}}E_r \sin\left(\frac{2\pi t}{T}+\frac{2\pi x}{\lambda}\right) \tag{20}$$

The ratio

$$\frac{E_r}{E_o}=\rho \tag{21}$$

is called the reflection ratio and is analogous to the voltage reflection ratio of transmission lines.

Equation (19) can also be expressed in terms of products of sine functions by expansion of the traveling wave terms. This leads to

$$E_y=(E_o+E_r)\sin\frac{2\pi t}{T}\cos\frac{2\pi x}{\lambda}-(E_o-E_r)\cos\frac{2\pi t}{T}\sin\frac{2\pi x}{\lambda} \tag{22}$$

Here we have two alternating waves of different amplitude, stationary in space, but in time and space quadrature. Their superposition results in

$$E_y=\sqrt{(E_o+E_r)^2\cos^2\frac{2\pi x}{\lambda}+(E_o-E_r)^2\sin^2\frac{2\pi x}{\lambda}}\cdot\sin(\omega t-\Phi) \tag{23}$$

At each point in space we now find a fixed amplitude, of maximum value $|E_o|+|E_r|$ and of minimum value $|E_o|-|E_r|$; the bars denote absolute values, independent of sign. On account of the fixed character of the distribution, this compound wave is called a standing wave and the ratio

$$\frac{|E_o|+|E_r|}{|E_o|-|E_r|}=SWR \tag{24}$$

is called "Standing-Wave-Ratio." Suppression of the reflected wave E_r, or approximation to $SWR=1$ are the principle objectives of effective designs for transmission systems of any kind.

ENERGY TRANSPORT IN THE UNIFORM PLANE WAVE

In order to find the local energy density of the electromagnetic field constituting the uniform plane wave, consider an infinitesimal capacitor with plates perpendicular to the electric field vector E_y, as in Figure 6. From circuit theory the energy of a capacitor is known to be

$$W_e=\tfrac{1}{2}QV \tag{25}$$

where Q is the charge on one plate and V the voltage

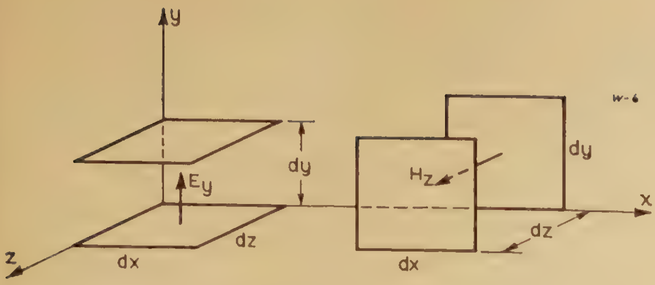

Figure 6. Local energy densities in electric and magnetic field

between the plates. Here, on account of the differential dimensions, and using equation (7), one can take

$$dV = E_y dy, \quad dQ = D_y dx dz = \epsilon E_y dx dz$$

so that

$$dW_e = \tfrac{1}{2} E_y D_y dx dy dz = \tfrac{1}{2} \epsilon E_y^2 d\tau$$

The local energy density of the electric field, therefore, follows as

$$w_e = \frac{dW_e}{d\tau} = \tfrac{1}{2} E_y D_y = \tfrac{1}{2} \epsilon E_y^2 \tag{26}$$

For the magnetic component one has to assume a pair of vertical pole shoes of ideal, infinite permeability, a distance dz apart, as seen in Figure 6. The energy of an idealized electromagnet is

$$W_m = \tfrac{1}{2} \Phi_m \mathfrak{F}$$

where Φ_m is the total magnetic flux and $\mathfrak{F}$ the total magnetomotive force of the gap. Here, on account of the differential dimensions, and using relation (2), one can take

$$d\mathfrak{F} = H_z dz, \quad d\Phi_m = B_z dx dy = \mu H_z dx dy$$

so that

$$dW_m = \tfrac{1}{2} H_z B_z dx dy dz = \tfrac{1}{2} \mu H_z^2 d\tau$$

The local energy density of the magnetic field, therefore, is

$$w_m = \frac{dW_m}{d\tau} = \tfrac{1}{2} H_z B_z = \tfrac{1}{2} \mu H_z^2 \tag{27}$$

and by use of (18) can be shown to be identical with the value for W_e. In a uniform plane wave, therefore, electric and magnetic energy densities are exactly equal, or the reactive energies balance their effects at each point leaving only active power flow.

On account of the generality of the derivation, one can immediately conclude that in any electromagnetic field, the energy densities must be given by

$$w_e = \tfrac{1}{2} \boldsymbol{E} \cdot \boldsymbol{D}, \quad w_m = \tfrac{1}{2} \boldsymbol{H} \cdot \boldsymbol{B} \tag{28}$$

These are fundamental hypotheses of Maxwell's field theory.

To get a clear insight into the energy values transported by the uniform plane wave, multiply equation (11) by E_y and subtract from it equation (12) after having multiplied it by H_z. This gives

$$-E_y \frac{\partial H_z}{\partial x} - H_z \frac{\partial E_y}{\partial x} = \epsilon E_y \frac{\partial E_y}{\partial t} + \mu H_z \frac{\partial H_z}{\partial t}$$

One can easily identify the terms on the right-hand side as the time derivatives of (26) and (27), respectively, while the left-hand side can be transformed into time derivatives by the use of the identity (17*a*) for both $\partial H_z/\partial x$ and $\partial E_y/\partial x$. We thus obtain

$$\frac{1}{v}\left[E_y \frac{\partial H_z}{\partial t} + H_z \frac{\partial E_y}{\partial t}\right] = \frac{1}{v}\frac{\partial}{\partial t}(E_y H_z) = \frac{\partial}{\partial t}\left(\frac{1}{2}\epsilon E_y^2 + \frac{1}{2}\mu H_z^2\right)$$

or also, by direct time integration and disregarding the integration constant since only a-c quantities are involved,

$$E_y H_z = v(w_e + w_m) = vw \tag{29}$$

The right-hand side represents the total amount of power flowing per unit area in the direction of propagation with the phase velocity of the "progressive wave." One can now interpret the left-hand term as the value of a vector quantity $\boldsymbol{E}_y \times \boldsymbol{H}_z$, having the direction of power flow or radiation and giving the power flow density at each point in space. In fact, one can easily generalize for a dielectric medium and define $\boldsymbol{N} = \boldsymbol{E} \times \boldsymbol{H}$ as the power-flow vector, the graph of which gives the direction and intensity of radiation in watt per centimeter², at any point where an electromagnetic field exists. The vector $\boldsymbol{N}$ was introduced by Poynting[5] and is most important for all problems relating to radiation from antenna systems and electromagnetic orifices.

As a time function, the power-flow density according to (29) becomes with (17) and (18)

$$E_y H_z = \sqrt{\frac{\epsilon}{\mu}} \cdot E_o^2 \sin^2\left(\frac{2\pi t}{T} - \frac{2\pi x}{\lambda}\right) \tag{31}$$

Its value oscillates between maximum and zero, never becoming negative. Power is radiated in the uniform plane wave in the same manner as along a single phase, lossless transmission line.

It is illuminating to apply these concepts to the "standing wave" formed by the superposition of two oppositely traveling waves. For the energy densities according to (26) and (27) we must now use the resultant values of the field vectors (19) and (20) so that we have

$$w_e + w_m = \epsilon\left[E_o^2 \sin^2\left(\frac{2\pi t}{T} - \frac{2\pi x}{\lambda}\right) + E_r^2 \sin^2\left(\frac{2\pi t}{T} + \frac{2\pi x}{\lambda}\right)\right] \tag{32}$$

The value of the Poynting vector is now by direct use of (19) and (20)

$$E_y H_z = \sqrt{\frac{\epsilon}{\mu}} \cdot \left[E_o^2 \sin^2\left(\frac{2\pi t}{T} - \frac{2\pi x}{\lambda}\right) - E_r^2 \sin^2\left(\frac{2\pi t}{T} + \frac{2\pi x}{\lambda}\right)\right] \tag{33}$$

and is certainly not equal to phase velocity times total field energy density. Equation (33) gives the very plausible result that only the difference of the individual wave energies is propagated into the positive x direction.

There must then be locally stored an energy density of value

$$2E_r^2 \sin^2\left(\frac{2\pi t}{T}+\frac{2\pi x}{\lambda}\right) \tag{34}$$

bound by the fixed distribution of the field and simply acting as oscillatory reactive energy, in the same manner as the reactive energy on single phase transmission lines. The most interesting and important conclusion then can be drawn: Wherever there is reflection of an electromagnetic wave, there must be local reactive power oscillation, which cannot be utilized for radiation or transmission. The tremendous importance of "matching," that is, of avoiding reflections in transmission systems, thus becomes quite apparent.

UNIFORM PLANE WAVES IN CONDUCTORS

As long as we are only concerned with harmonic oscillations in steady state, it will be of advantage to use complex notation in the same sense as in conventional a-c circuit theory. Assume the same plane wave as in Figure 4 entering a conducting medium. Denote the physical quantities as

$$E_y=\mathrm{Im}(\bar{E}\epsilon^{j\omega t}),\quad H_z=\mathrm{Im}(\bar{H}\epsilon^{j\omega t}) \tag{35}$$

where "Im" means that only the imaginary part of the complex quantity must be used, the real part must be rejected. The amplitudes $\bar{E}$ and $\bar{H}$ are in general complex and can always be converted into polar form. In the case of solution (15) for a pure dielectric, the amplitude is obviously real.

With the definitions (35), one can rewrite the differential equations for a uniform plane wave from (11) and (12) as

$$-\frac{\partial \bar{H}}{\partial x}=\epsilon j\omega\bar{E}+\gamma\bar{E} \tag{36}$$

$$+\frac{\partial \bar{E}}{\partial x}=-\mu j\omega\bar{H} \tag{37}$$

where in (36) in addition to the dielectric current density also conduction current density $\gamma\bar{E}$ has been introduced in accordance with the complete Maxwell equation (9). Since there are no substances known with vanishing dielectric constant ϵ, the dielectric current will always be present. However, its value always will be small as we have shown already, so that its presence will be obscured by the conduction current, if the conductivity is reasonably large. We can arbitrarily classify media for which

$$\left.\begin{array}{ll}\gamma\ll\epsilon\omega, & \text{as dielectrics}\\ \gamma\gg\epsilon\omega, & \text{as conductors}\end{array}\right\} \tag{38}$$

All media for which γ is of the same order of magnitude as $\epsilon\omega$ we classify as semiconductors; their theory is rather involved. It is to be noted that the criterion contains frequency as a factor; one must therefore expect that certain media, which at low frequencies are good "conductors," change at high frequency to dielectric behavior. A striking example is average ground, for which one can assume $\epsilon_r=6$, $\gamma=10^{-5}$ mho per meter, so that $(\epsilon\omega)=6\dfrac{10^{-9}}{36\pi}2\pi f=3.33\times10^{-10}f$. For frequencies in the audio range, then, earth will act like a good conductor, that is, reflect very well, whereas for ultrahigh frequencies earth acts as a good dielectric. This is, of course, of particular significance for antenna radiation and for reception.

Restricting this discussion to "conductors," then, one obtains by differentiating (37) and introducing (36), the single differential equation

$$\frac{\partial^2\bar{E}}{\partial x^2}=+j\omega\mu\gamma\bar{E} \tag{39}$$

which has as a simple solution

$$\bar{E}=E_o\epsilon^{-\sqrt{j\omega\mu\gamma}\,x} \tag{40}$$

Since $\sqrt{j}=\dfrac{1+j}{\sqrt{2}}$, one can simplify by defining a quantity

$$\delta=\sqrt{\frac{2}{\omega\mu\gamma}}=\sqrt{\frac{1}{\pi\mu\gamma f}} \tag{41}$$

so that

$$\bar{E}=E_o\epsilon^{-\frac{x}{\delta}}\cdot\epsilon^{-j\frac{x}{\delta}} \tag{42}$$

The real physical field component is, then,

$$E_y=\mathrm{Im}(\bar{E}\cdot\epsilon^{j\omega t})=E_o\cdot\epsilon^{-\frac{x}{\delta}}\sin\left(\omega t-\frac{x}{\delta}\right) \tag{43}$$

permitting a very simple and instructive interpretation. Again, we have a progressive wave of the same general type as in the dielectric, and comparison with (17) indicates that a wave length in the conductor can be defined as

$$\lambda_c=2\pi\delta \tag{44}$$

But this wave is now attenuated exponentially as it penetrates into the conductor. For $x=\delta$ the amplitude has decreased to $1/e$, and for $x=3$ it has diminished to five per cent of the value at $x=0$. The quantity δ is therefore a measure of the depth to which a wave practically penetrates into a conductor and it is called "depth of penetration." Equation (44) shows that within one-half conductor wave length the field has practically vanished. Since the phase velocity is defined by λf in general, one finds with (44) and (41)

$$v_c=\lambda_c f=2\pi\delta f=2\sqrt{\frac{\pi f}{\mu\gamma}} \tag{45}$$

which indicates "dispersion."

It is necessary to consider numerical values in order really to appreciate fully the implications of this solution. Take copper as the conductor, then $\mu=4\pi\times10^{-9}$ henrys

per centimeter, $\gamma=5.82\times10^5$ mho per centimeter, and we obtain

$$\delta=\frac{6.6}{\sqrt{f}}\text{ centimeter},\quad \lambda_c=\frac{41.4}{\sqrt{f}}\text{ centimeter},\quad v_c=41.4\sqrt{f}\text{ centimeter per second} \tag{46}$$

Thus for $f=100$ megacycles per second, the electromagnetic field penetrates into copper only $3\delta=0.002$ centimeter, or less than 0.001 inch, with a wave length in free space of $\lambda_0=c/f=300$ centimeters changed to $\lambda_c=0.00414$ centimeter, and with a velocity of propagation in free space of $c=3\times10^{10}$ centimeter per second changed to $v_c=4.14\times10^6$ centimeter per second. This means that metallic conductors at high frequencies vigorously repel the electromagnetic field, confining it to an extremely thin layer.

The amplitude of the magnetic field component $\bar{H}$ is obtained from (37) with (40)

$$\bar{H}=-\frac{1}{j\mu\omega}\frac{\partial\bar{E}}{\partial x}=\sqrt{\frac{\gamma}{j\omega\mu}}\,\bar{E}=\frac{\gamma\delta}{\sqrt{2}}\,\bar{E}\epsilon^{-j\pi/4} \tag{47}$$

Obviously, the magnetic field in a good conductor everywhere lags 45 degrees behind the electric field. Its value on the surface $x=0$ measures the total current in the conductor below the surface. Thus, integrating the conduction current density $\gamma\bar{E}$ over the entire thickness of the conductor, which might be taken as infinite since the field attenuates so extremely rapidly, gives with (40)

$$J_y=\int_{x=0}^{x=\infty}\gamma\bar{E}dx=-\frac{\gamma}{\sqrt{j\omega\mu\gamma}}\,\bar{E}_o\epsilon^{-\sqrt{j\omega\mu\gamma}x}\Big]_0^\infty=+\frac{\gamma\delta}{\sqrt{2}}\bar{E}_o\epsilon^{-j\pi/4} \tag{48}$$

the total current along the y direction through an infinite strip of unit width along the z direction. This value (48) is exactly the same as the complex amplitude $\bar{H}$ taken at $x=0$, to wit from (47)

$$\bar{H}_{x=0}=\frac{\gamma\delta}{\sqrt{2}}\bar{E}_o\epsilon^{-j\pi/4} \tag{49}$$

These are two results of great significance in connection with practical solutions of ultrahigh frequency problems: the knowledge of the complex amplitude of the tangential magnetizing force $\bar{H}_o$ on the surface of a conductor (1) immediately permits the evaluation of the associated tangential electric field $\bar{E}_o$ perpendicular to $\bar{H}$ on the surface of the conductor by generalization of (49)

$$\bar{E}_o=\bar{H}_o\sqrt{2}\,\frac{\epsilon^{j\pi/4}}{\gamma\delta} \tag{50}$$

and (2) also gives the total current in the conductor in direction of the electric field $\bar{E}_o$ per unit width taken in the direction of the magnetic field,

$$\bar{H}_o=J \tag{51}$$

GENERALIZED ENERGY RELATIONS AND IMPEDANCE CONCEPT

With the use of the complex notation, it is possible, in a comparatively simple manner, to deduce equivalent impedance characteristics of finite field spaces so that again circuit concepts can be applied. Take the one dimensional field equation (36). As a complex equation it actually means two real equations, one for the real parts and one for the imaginary parts. Nothing can change in these equations, if we write (36) for the conjugate complex quantities, since this simply means to replace each j by $(-j)$ and must lead to the same final real equations. Denoting the conjugate quantities to $\bar{E}$ and $\bar{H}$ by $\bar{E}^*$ and $\bar{H}^*$, we have

$$-\frac{\partial\bar{H}^*}{\partial x}=-\epsilon j\omega\bar{E}^*+\gamma\bar{E}^* \tag{52}$$

Now multiply both sides of (52) by $\bar{E}$ and those of (37) by $\bar{H}^*$ and subtract the two resulting equations

$$-\bar{E}\,\frac{\partial\bar{H}^*}{\partial x}-\bar{H}^*\frac{\partial\bar{E}}{\partial x}=j\omega(\mu\bar{H}\bar{H}^*-\epsilon\bar{E}\bar{E}^*)+\gamma\bar{E}\bar{E}^*$$

The product of two conjugate complex quantities is real and is the absolute square of the amplitude, so that $\bar{H}\bar{H}^*=2H^2$, if H is rms value of the magnetizing force, and similarly for the electric field vector. One can therefore restate

$$-\frac{\partial}{\partial x}(\bar{E}\bar{H}^*)=4j\omega(w_m-w_e)+2p_d \tag{53}$$

where p_d is the loss per unit volume by dissipation in joule heat. If one integrates over any finite volume, the left-hand side becomes a surface integral

$$-\int\!\!\int\!\!\int\frac{\partial}{\partial x}(\bar{E}\bar{H}^*)dxdydz=-\oint\!\!\oint(\bar{E}\bar{H}^*)dS$$

and finally

$$-\frac{1}{2}\oint\!\!\oint(\bar{E}\bar{H}^*)dS=2j\omega(W_m-W_e)+P_d \tag{54}$$

All the physical quantities on the right-hand side are now real, W_m is the total magnetic, W_e the total electric field energy within the volume τ, and P_d is the total amount of power dissipated into heat in the same volume, while the left-hand side must represent the total inflow (negative) of power over the surface S of the volume with no source within the volume. The surface integration

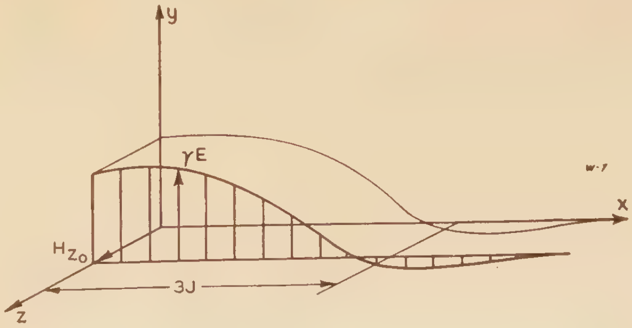

Figure 7. The magnetic field on conductor surface measures the total current in the conductor

of the complex product $\frac{1}{2}(\bar{E}\bar{H}^*)$ delivers, therefore, in its real part the dissipation, in its imaginary part the reactive power within the volume τ.

Again one can generalize, consider the product of the field vectors as a vector product, and introduce

$$\bar{N} = \bar{E} \times \bar{H}^* \tag{55}$$

as the complex Poynting vector. It has no direct physical significance, but its integral has the meaning of (54), or generally for any field distribution

$$-\frac{1}{2} \oint\!\!\oint (\bar{E} \times \bar{H}^*) \cdot dS = P_d + 2j\omega(W_m - W_e) \tag{56}$$

If now it is possible to define a significant current within the volume, such that

$$P_d = RI^2, \qquad W_m = \frac{1}{2} LI^2, \qquad W_e = \frac{1}{2} \frac{Q^2}{C} = \frac{1}{2C}\left(\frac{I}{\omega}\right)^2 \tag{57}$$

then the interesting result is obtained

$$-\frac{1}{2} \oint\!\!\oint (\bar{E} \times \bar{H}^*) \cdot dS = I^2\left[R + j\left(\omega L - \frac{1}{\omega C}\right)\right] = I^2 Z \tag{58}$$

This equation constitutes the most direct link between a space of volume filled with an electromagnetic field and the equivalent circuit configuration as a double energy circuit of complex impedance Z. Difficulties in application usually result from the inability to define a definite, ideally measurable current I. Wherever such a definition is possible, equation (58) defines the impedance of the field space in a unique way.

We can apply this definition easily to obtain the power absorbed by a conductor if the surface field is known. Assume an infinite parallel prism with unit area in the y-z plane of Figure 7 as base and extending along the positive x axis. Energy flows into the system only over the base, where the tangential field components are supposedly known. Assuming $\bar{H}_o$ as the value of the magnetizing force, then $\bar{H}_o^*$ is the conjugate complex value, and $\bar{E}_o$ follows from (50). Since there is no variation over the unit area, the product of the two quantities will give $\bar{N}^*$, directed into the surface, so that it has to be taken negative. The total current has a complex amplitude given by (51), so that the rms value is

$$J^2 = \frac{1}{2}\bar{J}\bar{J}^* = \frac{1}{2}\bar{H}_o\bar{H}_o^*$$

Equation (58) now becomes per unit area

$$\frac{1}{2}\bar{H}_o\sqrt{2}\,\frac{e^{j\pi/4}}{\gamma\delta}\cdot\bar{H}_o^* = J^2 Z = \frac{1}{2} H_o H_o^* Z$$

or else

$$Z = \frac{\sqrt{2}}{\gamma\delta} e^{j\pi/4} = \frac{1+j}{\gamma\delta} = \frac{1}{\gamma\delta} + j\frac{1}{\gamma\delta} \text{ ohm} \tag{59}$$

A "conductor" always represents a highly inductive impedance. If it is part of the boundary of a field space in a pure dielectric, then its resistance usually represents the only resistance, and its inductance has to be added to the inductance of the dielectric space. A good conductor

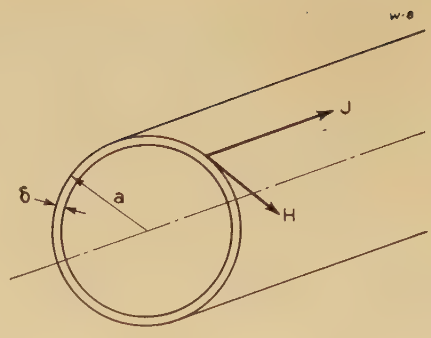

Figure 8. Skin effect in round conductor

by itself has therefore a $Q = \omega L/R = 1$ under all conditions.

The result (59) can also be applied immediately to evaluate the resistance of a round conductor on account of skin effect. As shown in Figure 8 the current flows parallel to the axis of the conductor. Equation (59) gives, therefore, the impedance for unit length along the axis and unit length along the periphery. To obtain the series impedance per unit length we only have to divide by the perimeter $2\pi a$ and obtain

$$r + j\omega l = \frac{1}{2\pi a}\,\frac{1}{\gamma\delta}\,(1+j) \tag{60}$$

and with the appropriate values for copper as for (46), one finds

$$r = \frac{1}{2\pi a\gamma\delta} = 0.416 \times 10^{-7}\,\frac{\sqrt{f}}{a} \text{ ohm per centimeter} \tag{61}$$

This expression holds irrespective of whether the current flows on the inside or outside of a round conductor, as long as the thickness of the metal is large compared with the depth of penetration δ.

In order to obtain the radiation characteristics from a source in terms of power-flow density, one can, of course, use the real Poynting vector defined in (30). If one is interested only in time averages of power flow, as usually in radiation problems, one can also use the complex Poynting vector. One can easily show that for two complex exponential time functions $\bar{F}_1$ and $\bar{F}_2$ the relation holds[6]

$$[(\mathrm{Im}\bar{F}_1)(\mathrm{Im}\bar{F}_2)]_{\text{average}} = \frac{1}{2}\,\mathrm{Re}\,[\bar{F}_1\bar{F}_2^*] \tag{62}$$

where "Re" means that only the real part of the bracket expression is to be used. Since the real physical field quantities are defined in (35) as the imaginary parts of complex time functions, one can immediately deduce

$$(N)_{\text{average}} = (E \times H)_{\text{average}} = \frac{1}{2}\,\mathrm{Re}\,[E \times H^*] \tag{63}$$

A plot of this vector quantity over a sphere surrounding the radiator is usually called radiation "pattern."

If the Poynting vector of (62) is integrated over a closed surface, preferably a very large sphere, surrounding a radiator of any sort, one obtains the total power radiated from the system. By proper definition of the current, in the radiator, one can then define

$$P_{\text{Rad}} = \oint\!\!\oint \frac{1}{2}\,\mathrm{Re}\,[\bar{E} \times \bar{H}^*] \cdot dS = R_{\text{Rad}} I^2 \tag{64}$$

where R_{Rad} is called the radiation resistance of the system. Obviously, for equal currents the system with higher radiation resistance will be the more efficient over-all radiator. Generally, however, considerations of directivity enter at very high frequencies, namely, how much of the total power radiated can be "beamed" into the most desirable direction.

In plane waves one can use the mutually perpendicular electric and magnetic field components to define a transmission impedance

$$Z_{tr} = \frac{\bar{E}}{\bar{H}} \tag{65}$$

which has special significance in wave-guide problems.[7] In the case of the uniform plane wave in a conductor, we would have from (47)

$$Z_{tr} = \frac{\bar{E}}{\bar{H}} = \frac{\sqrt{2}}{\gamma\delta} \cdot e^{+j\pi/4}$$

which happens to be the same value found by the application of Poynting's theorem in (59). For uniform plane waves the two rather different definitions will always give the same result; in general, one has to expect different values. A unique definition of impedance for field propagation has not yet been found and is particularly difficult on account of the distributed nature of the current.

THE BOUNDARY CONDITIONS ON THE ELECTROMAGNETIC FIELD

So far, the electromagnetic field has been considered only within a single medium of uniform characteristics. Since within each medium the field will differ with conductivity, dielectric constant, and permeability, it is necessary that certain discontinuities will appear on boundary surfaces, yet the field distribution must satisfy Maxwell's field equations even on the boundary surface. In fact, it is fairly simple to deduce the "boundary conditions" directly from the field equations (9) and (10).

Referring to Figure 9, assume the boundary plane to coincide with the y-z plane of a right-handed co-ordinate system at least for the neighborhood of the point P, and let the positive x axis point into the medium 2 with γ_2, ϵ_2, μ_2, while to the left of the boundary plane we have medium 1 with γ_1, ϵ_1, μ_1 as characterisic constants. Select now a very thin rectangular path of differential dimensions with the two larger sides in the two different media, in fact let the height $dh \to 0$, that is, reduce the path to two parallel lines on the two opposite sides of the boundary plane. Then, application of the first Maxwell equation (9) leads to

$$H_{y_1}dy - H_{y_2}dy = \lim_{dh\to 0}\left[G_z + \frac{d}{dt}D_z\right]dhdy \tag{66}$$

since only current in the z direction really penetrates the loop in the x-y plane. The conduction current i' has been defined here as conduction current density G_z multiplied by the differential area $dhdy$. Now, as dh goes to zero, the right-hand side vanishes, unless simultaneously for example, G_z should become infinitely large. In many practical cases, it will be advisable to consider in first approximation, the depth of penetration in conductors as infinitely thin so that the total current J per unit width be compressed into zero thickness, thus constituting just the case considered. One then introduces

$$\lim_{\substack{G\to\infty \\ dh\to 0}} Gdh = J \tag{67}$$

and calls J the sheet-current density measured in amperes per centimeter width of conductor. It has not been feasible to use a similar concept for the dielectric current, so that (66) reduces to

$$H_{y_1} - H_{y_2} = J_z \tag{68}$$

and similarly for the other tangential components

$$H_{z_1} - H_{z_2} = J_y \tag{69}$$

Exactly the same method can be used in applying the second field equation of Maxwell to the boundary surface, whereby the right-hand term always vanishes with $dh \to 0$, so that one has

$$E_{y_1} = E_{y_2},\ E_{z_1} = E_{z_2} \tag{70}$$

for the chosen orientation of the arbitrary co-ordinate system. One can express these four boundary conditions simpler by stating that all tangential field components must be continuous through boundary surfaces except in the case where a current sheet exists; in this latter case the difference of the tangential magnetizing force is equal to the perpendicular sheet-current density. These conditions are necessary and sufficient to solve at least formally any field problem whatsoever.

One can draw readily a few interesting conclusions:

1. The very high conductivity of metals tolerates only a very small electric field strength in metals. At the boundary of metal

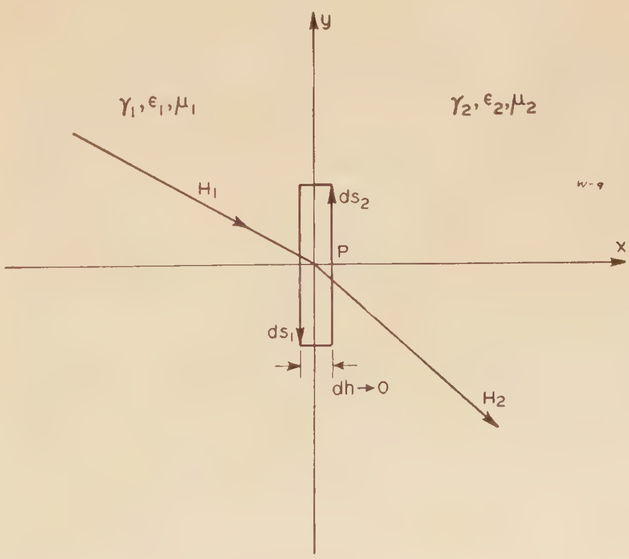

Figure 9. Boundary conditions on electromagnetic field

against dielectric, the electric field vector is therefore practically perpendicular to the metal surface. As an example, take copper against air; the order of magnitude of electric field strength in copper is 10^{-2} volt per centimeter, whereas in air on metal surfaces, about 10^2 volt per centimeter can be expected. Thus the deviation from the normal is $\tan^{-1}(10^{-4}) = 20$ seconds, imperceptibly small.

2. Close to metal surfaces, the Poynting vector is practically parallel to the surface for the same reason that the electric field is practically normal to it, as shown in 1. The very slight normal component points into the metal and covers the joule losses of the conduction current. The metal, therefore, according to Maxwell's field theory, never carries the energy transmitted by the system, it only guides it by providing a practical short circuit for the electric field.

3. In solving field distributions involving metal boundary surfaces, as in transmission lines of all types, wave guides, resonators, and other systems, one can reduce materially the mathematical complexity of the problem by first assuming that the tangential electric field vanishes on all metal surfaces. This will lead to a definite value for the tangential magnetizing force, $\bar{H}_o$, on the metal surface, which in turn can be used by (50) to obtain the approximate finite value of $\bar{E}_o$ on the metal surface as a second approximation. It is not necessary to extend this correction to the entire field distribution, again on the basis of the arguments under 1. In fact, it is only necessary to compute $\bar{E}_o$ in order to find the losses in the metal.

CONCLUSION

It has been attempted to present in a few pages material that is usually covered in volumes. That one cannot do justice to the subject matter in such limited space is clear. However, there are a number of excellent reference books[1–7] now available, treating one or the other phase of the vast scope of theory and applications. The references to books on electromagnetic theory[8–24] comprise a selected list of books, not at all exhaustive. According to the individual background and preference for completeness, reference should be made to one or more books for the details which a searching study of electromagnetic theory will reveal.

The Berkshire Museum, where some of the sessions of the AIEE District technical meeting in Pittsfield, Mass., will be held

Bartlett Hendricks photo

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24. Electromagnetic Waves, **F. W. G. White.** Methuen monograph, London, England, 1942. Very concise presentation of the field theory and selected applications.

INSTITUTE ACTIVITIES

North Eastern District Technical Meeting to Be Held at Pittsfield, Mass., April 8–9

Arrangements for the AIEE North Eastern District technical meeting which will be held in Pittsfield, Mass., April 8–9, 1943, include five conference sessions, a general session, and three technical sessions. Meeting headquarters will be at the Wendell Hotel. Some sessions will be held in the hotel and the others in the Berkshire Museum auditorium across the street.

The primary consideration in planning the program has been the selection of subjects of importance to electrical engineers in fulfilling their professional duties in wartime. By eliminating all nonessential elements, a full technical program is presented in two days instead of the usual three days, permitting the most efficient utilization of members' time. The five conference sessions will facilitate the free exchange of ideas on problems of timely importance to engineers. These conferences will consist of short prepared talks by authoritative speakers, followed by informal general discussions in which individual problems may be considered.

Situated in the Berkshire Hills, Pittsfield and Berkshire County have made many notable contributions in the fields of science, literature, and the arts. With the advent of electrical engineering, Pittsfield has become of national importance to the industry.

As an advance feature, a tri-Sectional competition meeting will be held in the Berkshire Museum auditorium, on April 7 at 8 p.m. Young engineers of the AIEE

Tentative Technical Program and Features

Wednesday, April 7

8:00 p.m. Advance Session

Tri-Sectional competition meeting sponsored by the Schenectady, Lynn, and Pittsfield Sections

Thursday, April 8

9:00 a.m. Power Transmission and Distribution

43-64. A New Control System for Automatic Parallel Operation of Load Ratio Control Transformers. **S. Minneci, S. B. Farnham,** General Electric Company

43-65. Use of Equivalent Annual Ambient in Overloading Transformers and Voltage Regulators. **M. S. Oldacre,** Commonwealth Edison Company

43-66. The Frequencies of Natural Power Oscillations in Interconnected Generating and Distribution Systems. **Reinhold Rüdenberg,** Harvard University

43-73. Electric Rating of Overhead Line Wire. **Myron Zucker,** The Jam Handy Organization (on leave from The Detroit Edison Company)

43-67. The Sorocabana Railway Electrification. **Durval Muylaert,** Sorocabana Railway (Presentation by title)

9:00 a.m. Measurements and Instrument Transformers

43-68. Potential Transformer Ratio and Phase Angle From a Capacitance Standard. **H. W. Bousman, R. L. Ten Broeck,** General Electric Company

43-69. Interim Report on Application and Operation of Circuit Breakers and Switchgear Subcommittee on Circuit Breakers, Switches, and Fuses

43-70. Overvoltage Protection of Current Transformers and Associated Secondary Circuits. **R. H. Kaufman, G. Camilli,** General Electric Company

43-71. New Developments in Potential Transformer Design. **G. Camilli,** General Electric Company

2:00 p.m. General Session

Address by **H. S. Osborne,** president AIEE

Address: "Sleet Damage on Overhead Lines." **J. F. Burt,** Western Massachusetts Company

*CP: Conference paper; no advance copies are available; not intended for publication in *Transactions.*

● PAMPHLET reproductions of authors' manuscripts of the numbered papers listed in the program may be obtained as noted in the following paragraphs.

● ABSTRACTS of most papers will appear in the April issue.

● PRICES and instructions for procuring advance copies of these papers will accompany the abstracts. Mail orders are advisable, particularly from out-of-town members, as an adequate supply of each paper at the meeting cannot be assured. Only numbered papers are available in pamphlet form.

● COUPON books in $5 denomination are available for those who may wish this convenient form of remittance.

● THE PAPERS regularly approved by the technical program committee ultimately will be published in "Transactions"; many will appear in "Electrical Engineering."

3:00 p.m. Conference—AIEE Sections and Municipal Planning

There will be presented at this conference case histories of successful local engineering councils and municipal research and planning projects sponsored and supported by engineering groups in various parts of the country as a guide to those sections of the Institute which have not as yet considered participation in civic engineering.

3:00 p.m. Conference for Industrial Operators of Electrical Equipment

Topics to be discussed include organizing of clinics for industrial operators of electrical apparatus to review methods of getting the maximum output and life from existing equipment; protective lighting in industrial plants; and safety precautions for industrial operators

6:00 p.m. Vice-Presidential Reception

6:30 p.m. Get-Together Dinner

Presentation of District prizes for papers

Address: "Railroad Transportation in the Present Emergency." **C. E. Smith,** vice-president, New York, New Haven, and Hartford Railroad

Friday, April 9

9:00 a.m. Plastics

CP.* Thermoplastics in the Electronic World of Tomorrow. **H. K. Nason,** Monsanto Chemical Company

CP.* Characteristics and Properties of Thermosetting Plastic Material. (Author to be announced), Bakelite Corporation

CP.* Plastic Parts Design. **W. S. Larson,** General Electric Company

CP.* The Application of Laminated Plastic Products in the Electrical Industry. **P. B. Leverette,** General Electric Company

9:00 a.m. Electric Welding Conference

Applications of a-c and d-c arc welding and electric brazing will be reviewed in the light of recent developments. The program includes movies and exhibits.

2:00 p.m. Conference on Electronics and Communications

CP.* Talks will be presented on radio communication from vehicles and airplanes in motion.

43-72. Train Communication. **L. O. Grondahl, P. N. Bossart,** Union Switch and Signal Company (Presentation by title)

CP.* Amplidynes, Covering Basic Circuit Diagrams, Nomenclature, and Transient Characteristics

CP.* Methods of Reduction of Radio Noise

2:00 p.m. Wartime Problems of Technical Personnel

These problems of vital interest to the armed forces, industry, and those in the educational field will be presented from the following points of view.

Colonel Herman Beukema, director of specialized training, United States Army

Joseph W. Barker, special assistant to the Secretary of the Navy

The War Manpower Commission. **William C. White,** dean of engineering, North Eastern University

Future AIEE Meetings

District Technical Meeting
Pittsfield, Mass., April 8–9, 1943

District Technical Meeting
Kansas City, Mo., April 28–30, 1943

National Technical Meeting
Cleveland, Ohio, June 21–25, 1943

National Technical Meeting
Salt Lake City, Utah, September 2–4, 1943

Schenectady, Lynn, and Pittsfield Sections who have not previously presented papers at national AIEE meetings will speak in competition. This meeting is sponsored by the three local Sections involved.

SPECIAL FEATURES

After luncheon on Thursday, April 8, AIEE President H. S. Osborne will address a general session in the auditorium of the Museum. The concluding event at this session will be an address by J. F. Burt of the Western Massachusetts Companies, who will show still and motion pictures of sleet-storm damage to overhead lines.

There will be a get-together dinner at the Wendell Hotel on Thursday, April 8, at 6:30 p.m. Following the dinner, C. E. Smith, vice-president of the New York, New Haven and Hartford Railroad, will speak on "Railroad Transportation in the Present Emergency." Having had a long and colorful career in railroading, as well as having served during 1918 as major in the Construction Division, United States Army, the speaker is particularly well qualified to present this subject.

EXHIBITS

In lieu of inspection trips, which are impractical under wartime conditions, it is planned to have at the Museum interesting exhibits of products of the various industries in the Pittsfield district. These exhibits will be on display during April 8–9, so that those attending the meeting may see them at their convenience.

RESERVATIONS AND REGISTRATION

Members are asked to register in advance by writing R. F. Morrier, 100 Woodlawn Avenue, Pittsfield, Mass., and to complete their registration at the Wendell Hotel. A registration fee of $2.00 will be charged all nonmembers, except Enrolled Students and the immediate families of members.

Members and guests should make their hotel reservations by writing to S. Terpak, 100 Woodlawn Avenue, Pittsfield, Mass.

COMMITTEES

General Committee: L. Wetherill, *chairman;* E. V. DeBlieux, C. W. Germeck, J. H. Hagenguth, E. K. Kane, R. G. Lorraine, D. D. MacCarthy, K. B. McEachron, R. F. Morrier, C. A. Read, J. O. Roser, W. J. Rudge, J. C. Russ, S. Terpak.

Technical Program: E. V. DeBlieux, *chairman;* A. Boyajian, G. Camilli, R. E. Coates, J. C. Howes, F. H. Judkins, P. B. Leverette, S. Minneci, H. M. Richardson, P. B. Sowell, J. L. Thomason.

Tri-Sectional Competition: J. C. Russ, *chairman;* H. W. Allison, P. N. Bosworth, J. H. Hagenguth, B. M. Harris, L. W. Marks, H. Shubert, C. W. Wertz, S. W. Zimmerman.

Exhibits: W. J. Rudge, *chairman;* G. F. Lincks.

Publicity: D. D. MacCarthy, *chairman;* E. J. Allen, C. A. Beers, R. A. Browne, E. A. Elge, T. D. Gordy, J. W. Kalb, C. W. Kellogg, E. W. Manning.

Dinner: E. K. Kane, *chairman;* J. R. Barr, C. A. Beers.

Finance: J. H. Hagenguth, *chairman.*

Registration: R. F. Morrier, *chairman.*

Information: C. A. Read, *chairman.*

Hotels: S. Terpak, *chairman;* L. W. Marks, C. W. Wertz.

South West District to Meet in Kansas City

The AIEE South West District technical meeting will be held concurrently with the annual meeting of the Missouri Valley Electrical Association, April 28–30, 1943, at Kansas City, Mo. Headquarters for the meeting will be in the Hotel Continental.

The program has been designed with the war effort in view. Since power problems are of particular interest to both groups, and since both share a great many members, it was thought fitting that the two meetings be combined. This will be the 15th annual meeting of the MVEA, a regional association formerly affiliated with the National Electric Light Association.

The opening session will include addresses by H. S. Osborne, president, AIEE; A. L. Mullergren, president, MVEA; and E. T. Mahood, AIEE vice-president representing the South West District. Following these addresses H. L. Clesen will speak on electrical indicating instruments in connection with the war effort.

One of the high lights of the program will be a symposium on critical materials and equipment, scheduled for Thursday afternoon. This will be a general session with no other activities in parallel. Among the speakers are H. M. MacDougal of the War Production Board; President H. S. Osborne, and A. C. Monteith, chairman of the committee on power generation. It is intended to present the general idea of the operating guides and to present one or possibly two of the guides in some detail. A conference on Section operations and management is being planned by Walker Mier.

Arrangements for a student session are being made by Professor W. F. Gray, chairman of the District committee on student activities. A good attendance is assured by the fact that two of the Kansas schools and at least one of the Missouri schools plan to utilize the meeting as their annual senior inspection trip. As part of the student program, arrangements are being made by R. L. Baldwin to have a representative of each of the larger branches of the electrical industry available for consultation by those students who would like to talk with these men about work in private industry.

As usual, the entertainment features will be held mainly in the evenings. A smoker is being planned for the first evening of the meeting by the MVEA, and arrangements are being made for an AIEE dinner on the second evening. A luncheon will be held Thursday noon at which F. J. Meyer, director, and H. H. Henline, national secretary of AIEE, will speak on Institute activities.

STANDARDS . . .

AIEE Standards Being Revised to Meet Wartime Needs

Possible changes in AIEE standards made necessary by the war, and supplemental data needed to attain maximum conservation of critical materials are being considered by the AIEE technical committees, which, under the sponsorship of the standards committee, are reviewing many of our standards with wartime requirements in mind.

The present war emergency requires that the maximum possible use be made of all existing equipment and that a minimum amount of critical materials be used in the construction of new equipment. This has focused attention on the importance of the general use of industry standards and the advantages to be achieved through the formulation of any simplification program by established standardizing bodies.

Careful consideration has indicated that for many of the standards the situation may be taken care of very effectively and conveniently by the preparation of guides for the economical application and operation of electric apparatus, and for the limits of loading permissible under emergency conditions. In a few situations wartime standards may be prepared.

The War Production Board is keenly interested in this work. The guides, intended to be of direct practical use, are educational in character and are in no sense mandatory.

At the present time interim reports and proposed guides dealing with the subjects

Subject	Paper Number	Price by Mail (Cents)
Shunt capacitors	43-48	30
Power cables	*	*
Circuit breakers and switchgear	43-55	15
Generating equipment and systems	*	*
System grounding impedance	43-5	15
Industrial-power distribution systems	43-40	70
Electric motors and motor controllers	43-62	15
Automatic reclosing equipment on stub feeders	*	*
Power-transmission systems	*	*
Power transformers and regulators	42-156†	15
Distribution transformers and regulators	*	*
Current-limiting reactors	*	*

* Not yet available.

† Published in the *Transactions*, September 1942 section, pages 692–4.

listed in the accompanying table are in the process of preparation. Several were presented and discussed at the AIEE national technical meeting, New York, N. Y., January 25–29, 1943. Abstracts of these were published in the December 1942 and January 1943 issues of *Electrical Engineering*. Several of these reports and guides are practically completed; others are only in the formulative stage. Institute members may obtain copies of those available in pamphlet form from AIEE headquarters by referring to the paper number as listed in the table. (*J. R. North, chairman, AIEE standards committee.*)

New Transformer Standard

An approved American standard "Transformers, Regulators, and Reactors" (C57.1-C57.2-C57.3), developed by sectional committee C57 under the chairmanship of V. M. Montsinger (F '29), has just been issued by the American Standards Association. A preliminary edition of this document was published in 1940 for trial use during an 18-month period, and the present approved standard includes the revisions found necessary from practice. The data contained in the standard, while gathered from many sources, are based mainly on the standards formerly developed and published by the National Electrical Manufacturers Association and the AIEE.

General Electric photo

Plastic parts for aircraft. Plastics will be the subject of one of the sessions at the AIEE District technical meeting, Pittsfield, Mass., April 8–9

In addition to the standards for transformers, regulators, and reactors, the pamphlet also includes the test code and guides on operation. Copies of this 96-page publication can be obtained from AIEE headquarters, 33 West 39th Street, New York, N. Y., at a cost of $1.00 per copy to members of AIEE and $1.25 to nonmembers.

Wartime Problems Held the Spotlight at Winter National Technical Meeting

Maximum aid in the war effort was the principal objective of the AIEE national technical meeting held in New York, N. Y., January 25–29, 1943. This is in accord with the wartime policies adopted by the Institute's board of directors last August. As stipulated by those policies, all programmed social activities and inspection trips were omitted, leaving the entire week to be devoted to technical sessions and conferences.

Emphasis at many of the sessions and conferences was on the general problem of how to conserve critical materials, particularly copper and rubber, which form such vital parts of electric systems. Several of the wartime guides for emergency loading of the various parts of electric systems, now under preparation by several AIEE technical committees, were presented in preliminary form for discussion before preparation in final form. It was recognized that the reduction in life of equipment that would result from overloading beyond certain limits might even be justified in some instances during the present emergency. In general, the emphasis was on amperes rather than volts, with a view toward loading systems to their maximum current-carrying capacities and disregarding, or at least relegating to a position of secondary importance, the previously prevailing factor of voltage regulation.

A report of the accomplishments of the AIEE special committee on co-operation with war agencies was presented at the meeting of the board of directors held January 28. Among important actions relating to the war effort taken at this meeting were: authorization of a communication to the War Manpower Commission urging that a technical training program be established to prepare men for wartime industry; and adoption of provisions whereby AIEE members and enrolled students in the armed services of the United States and the merchant marine may maintain an "inactive" membership status for the duration of the war.

At a dinner meeting Tuesday evening, January 26, Doctor Vannevar Bush (F '24), president, Carnegie Institution of Washington, Washington, D. C., and director of the Office of Scientific Research and Development, delivered an address "Research in the War Effort" (published in full elsewhere in this issue). More than 1,100 members and guests attended.

Events related to other aspects of the war effort included: a conference on defense lighting; a general session on technical man power in the war effort at which representatives of both government and industry spoke; and a conference on wartime engineering education, which also was addressed by representatives of both government and industry and by prominent educators. Details of these and other features of the meeting are reported in separate items.

Analysis of Registration at 1943 Winter National Technical Meeting

Classification	Dist. 3	Dist. 1	Dist. 2	Dist. 4	Dist. 5	Dist. 6	Dist. 7	Dist. 8	Dist. 9	Dist. 10	Totals
Members	464	216	345	18	85	3	16	6	5	20	1,178
Men guests	69	25	51	3	10	3	1		1	4	167
Women guests	13	7	16	1	2					1	40
Students	23	6	5								34
Totals	569	254	417	22	97	6	17	6	6	25	1,419

REGISTRATION AND ATTENDANCE

This year's total registered attendance of 1,419 compares with 1,331 at last year's winter meeting, held shortly after the United States formally entered the war. Details and comparisons with previous years are given in the tabulations.

Attendance at sessions and conferences was particularly good, as indicated in an accompanying tabulation.

TECHNICAL SESSIONS AND CONFERENCES

More than 60 regular AIEE technical papers and a comparable number of informal conference papers were presented and discussed at 13 technical sessions and 12 technical conferences. The increase in technical conferences as compared with previous years reflects the trend toward more conferences and fewer formal technical sessions. This is in keeping with the times, as conferences usually can be arranged with less advance preparation than regular technical sessions.

Brief reports on all 12 conferences appear in the following pages. Such reports on the technical sessions as have been made available by session or committee chairmen likewise are included in succeeding pages.

JOINT AIEE-IRE SESSION ADDS INTERNATIONAL FLAVOR

Concurrently with the AIEE national technical meeting the Institute of Radio Engineers held its winter conference on Thursday, January 28, at the Engineering Societies Building. Many AIEE members attended the IRE sessions, and likewise many IRE members attended AIEE sessions and conferences, by previous joint arrangements between the two societies.

The arrangements culminated in a joint meeting held Thursday evening, January

28, at which Doctor George C. Southworth of Bell Telephone Laboratories, New York, N. Y., delivered the feature address entitled "Beyond the Ultra Shorts." This address covered in semipopular engineering language the development, transmission, and application of electric waves of ultrashort wave lengths. Haraden Pratt, past president of the IRE and current chairman of the AIEE committee on communication, presided.

Following Doctor Southworth's address the meeting assumed an international aspect as Sir Noel Ashbridge, chief engineer of the British Broadcasting Corporation, addressed the gathering by short-wave radio from London. He discussed broadcast operations in England under wartime conditions. At the conclusion of his remarks, there was a 15-minute nationwide radio-broadcast program during which the New York meeting was connected with a banquet held concurrently in Washington, D. C. Doctor L. P. Wheeler, president, IRE, broadcast a brief word of greeting from New York following an introduction by IRE junior past president Arthur F. Van Dyck, while from Washington the honorable James Lawrence Fly, chairman of the Board of War Communications, spoke.

Attendance at Sessions and Conferences of 1943 Winter National Technical Meeting

	Number Sessions and Conferences	Attendance
Monday a.m.	3	280
Monday p.m.	4	499
Tuesday a.m.	3	325
Tuesday p.m.	4	505
Wednesday a.m.	1*	425
Wednesday p.m.	3	375
Thursday a.m.	2	315
Thursday p.m.	2	170
Friday a.m.	3	315
Friday p.m.	1	138
Totals	26	3,347
Average per session or conference		128

* General session.

DIRECTORS AND COMMITTEES MEET

The AIEE board of directors and the national nominating committee met during the week of the winter technical meeting, as usual. Reports of both are given in separate items. In addition, scheduled meetings of the following committees and subcommittees were held:

Committees

AIEE—Engineering Foundation Research Project Insulating Oils and Cable Saturants; electrical machinery; Sections; Student Branches; safety; Lamme Medal; communication; planning and co-ordination; automatic stations; land transportation; membership; electronics; education; research; air transportation; Welding Research Council; industrial power applications; power generation; electrochemistry and electrometallurgy; protective devices; and basic sciences.

Subcommittees

Electronic devices; master test code for temperative measurements; voltage transients in arc-furnace circuits; stationary contact surfaces; circuit breakers, switches, and fuses; relay; transformer; insulation resistance; and distribution-type protector tube working group.

Available reports of these committee meetings are included in separate items.

WINTER TECHNICAL MEETING COMMITTEES

C. R. Jones, served as chairman of the national technical meeting committee; he was assisted by F. A. Cowan, W. S. Hill, M. D. Hooven, A. E. Knowlton, C. S. Purnell, R. L. Webb, and C. C. Whipple.

Acting on the IRE-AIEE co-operating committee were I. S. Coggeshall, F. A. Cowan, Dorman Israel, Louis Pacent, and H. A. Wheeler.

Technical Manpower Discussed at General Session

With a stipulated objective of presenting an up-to-the-minute picture of the technical manpower requirements of the armed services and plans for meeting these, a general session was held Wednesday morning, January 27, during the AIEE national technical meeting. The two feature addresses of the session covered respectively the specialized technical training programs established by the Army and the Navy in collaboration with leading educational authorities, to be carried out at educational institutions throughout the United States.

Prior to the feature addresses, Colonel R. G. Patterson, chairman of the War Savings Staff of New York City, spoke briefly on the subject of war-bond financing. AIEE President H. S. Osborne presided throughout the session.

Colonel Herman Beukema, director of the specialized training division, United States Army, Arlington, Va., discussed in detail the program established to provide the needed technical specialists for the Army. Doctor J. W. Barker (F '30) special assistant to the Secretary of the Navy, Washington, D. C., covered the Navy educational program and pointed out the similarities and differences as compared with the Army program. Essential substance of both addresses is presented in the lead articles of this issue.

R. E. Doherty (A '16, F '39) president, Carnegie Institute of Technology, Pittsburgh, Pa., discussing the speeches of the morning, declared that there must be a "continuous flow of young engineering blood into the industrial-engineering front." Doctor Doherty suggested (1) that the War Manpower Commission be urged to freeze status quo in colleges until a plan is worked out to provide a steady flow of engineering graduates and (2) that such a plan give the men in industrial scientific reserves as military a status as the specialists in the Army or Navy.

R. C. Muir (A '08, F '36) vice-president, General Electric Company, Schenectady, N. Y., added to the discussion a summary of the problems involved in relating the Army and Navy training programs to industry.

George T. Seabury, secretary of the American Society of Civil Engineers, New York, N. Y., discussed wartime problems of the civil engineer. Since the function of civil engineers is to prepare for construction and only to a lesser degree to engage in it, the expected decrease of war construction in 1943 added to priorities' limit on maintenance of present public utilities signifies that a large number of civil engineers during 1943 will be ready for reallocation or doomed to unemployment. Mr. Seabury pointed out the paradox of such a situation during a time when industry and the armed forces cry for more engineers. Mr. Seabury said: "The civil engineer is a man experienced particularly in the management of men and in the meeting of situations through the very nature of his work, which, in general, is that of going to a place where something is to be done, accepting the conditions as found at that place and utilizing them to his purpose. He is thus a man not only equipped with the engineering approach to a problem but is one of unusual adaptability to the circumstances which surround him and of which he must make use."

In England bombing has opened up new work for the civil engineer and constructor. Highways, railroads, underground utilities, and emergency water supplies must be constructed and maintained. However, in the United States, as long as the war is on, civil engineers apparently will not be employed in those pursuits in which they normally engage. Mr. Seabury urged that such men who are eager to contribute in the war effort "rather than sit idle, or perhaps volunteer for harvest work where avail will not be made of their special capabilities . . . . be used in the present planning of post-war construction, both for deferred community facilities in this country and for reconstruction of devastated areas of other countries."

Following Mr. Seabury's remarks, the session was opened for general discussion and questions during which Colonel Beukema and Doctor Barker expanded on their speeches.

Four Engineers Honored at National Technical Meeting

Special honors were bestowed upon four electrical engineers during the Institute's recent national technical meeting. At a special session held Wednesday evening, January 27, the AIEE Edison Medal was presented to Edwin H. Armstrong, professor of electrical engineering, Columbia University, New York, N. Y.; the John Fritz Medal to Willis R. Whitney (A '01), vice-president in general charge of research, General Electric Company, Schenectady, N. Y.; and the Hoover Medal to Gerard Swope (F '22), president, General Electric Company, New York, N. Y. President H. S. Osborne, who presided throughout the ceremonies, characterized the occasion as unique. He said that research has shown

Dr. Harold S. Osborne, president of the American Institute of Electrical Engineers, congratulates the three world-famous engineers who were awarded medals at the national technical meeting of the AIEE, January 27, 1943—Gerard Swope, winner of the Hoover Medal for 1942; Dr. Willis R. Whitney, winner of the John Fritz Medal for 1943; and Dr. Edwin H. Armstrong, winner of the Edison Medal for 1942. Mr. Swope is president of the General Electric Company; Dr. Whitney is honorary vice-president of General Electric and former director of the GE Research Laboratory; and Dr. Armstrong is professor of electrical engineering at Columbia University and developer of FM radio

that there is no case in history in which three of the highest honors of the engineering profession were bestowed upon three distinguished medalists in widely different fields of work in one evening. The fourth engineer honored was George W. Dunlap, Jr. (M '42), development engineer, General Electric Company, Schenectady, N. Y., who received the Alfred Noble Prize.

At the Wednesday evening ceremonies, the origin and history of the Edison Medal were outlined by Nevin E. Funk, chairman of the Edison Medal committee, and nominee for AIEE presidency for the year 1943–44. Alan Hazeltine, professor of physical mathematics, Stevens Institute of Technology, Hoboken, N. J., outlined Major Armstrong's career, after which President Osborne presented the medal to him.

F. Malcolm Farmer, AIEE past president, and a member of the John Fritz Medal Board of Award, which is made up of representatives from the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, described the John Fritz Medal and its importance in the engineering world. David C. Prince, also a past president of AIEE, reviewed in detail the life and work of Medalist Whitney, after which Mr. Farmer presented the medal.

The history of the Hoover Medal and the conditions under which it is awarded were outlined by Scott Turner, chairman of the Hoover Medal Board of Award, which is made up of representatives of the same four national societies that jointly award the John Fritz Medal. Karl T. Compton (F '31), president, Massachusetts Institute of Technology, Cambridge, recounted Medalist Swope's accomplishments in engineering and in public service, upon which the award of the medal is based. Following Doctor Compton's address, Doctor Turner presented the medal to Doctor Swope.

Full text of the addresses by Doctor Hazeltine, Mr. Prince, and Doctor Compton, as well as the responses of Medalists Armstrong, Whitney, and Swope, are scheduled for publication in an early issue of *Electrical Engineering*.

The Alfred Noble prize was presented to Doctor Dunlap during the general session Wednesday morning. Professor J. K. Finch, associate dean of the school of engineering, Columbia University, New York, N. Y., and former chairman of the Noble Prize committee, sketched the life and works of the engineer in whose honor the prize is awarded, and told how the award was established to recognize and encourage the young engineer. At the conclusion of his remarks, Professor Finch presented the certificate of award and a check for $350 to Doctor Dunlap.

Board of Directors Meets During National Technical Meeting

Establishment of a program for the training of engineers for industry, corresponding to the specialized training programs planned to furnish technical man power to the Army and Navy, was urged at the meeting of the AIEE board of directors held at Institute headquarters, January 28. In accordance with a recommendation adopted at the conference on wartime engineering education held January 27 during the AIEE national technical meeting, the board authorized a communication to the War Manpower Commission advocating the setting up of such a program to insure the proper allocation of technical man power to the nation's industries (see text of communication elsewhere in this issue).

The board adopted a resolution requesting the national secretary to convey to Director K. L. Hansen of Milwaukee the sympathy of the board in the death of his son, Lieutenant James S. Hansen. Lieutenant Hansen died in a crash, caused by explosion in mid-air of the army bomber he was piloting.

Chairman John C. Parker of the committee on co-operation with war agencies presented a report of the activities of that committee, as outlined elsewhere in this issue. The report was accepted by the board, and an additional amount of $500 was appropriated for the committee.

Upon request of the executive committee of the United States National Committee of the World Power Conference, the board adopted a resolution that each year the president of the Institute be designated a member of the executive committee of the United States National Committee of the World Power Conference, to serve for the period of his presidency.

Continuing the policy adopted in January 1942, a resolution was adopted removing from the membership list at this time the names of all delinquent members with whom it is impossible to communicate in those countries which have declared war against the United States, with the understanding that at the close of the war reinstatement may be effected in accordance with the usual procedure as provided in the Institute bylaws.

A resolution was adopted to the effect that the 1943 annual meeting of the Institute shall be held in Cleveland, Ohio, on June 21.

Dates selected by the local officers for the previously authorized national technical meeting in Salt Lake City, Utah, were approved, namely, September 2–4, 1943.

Chairman Prince of the committee on planning and co-ordination, which annually prepares a schedule of meetings for the following calendar year for submission to the board in January, reported that no requests had been received for national or District meetings in 1944. Upon recommendation of that committee, it was voted that the Sections and Districts be encouraged by the board of directors to request the usual number of meetings, to

be devoted to the war effort, or, in the event of a change in the international situation, to peace aims.

Upon petition from the required number of members and recommendation of the Sections committee, the board authorized the organization of a Montreal Section of the Institute, with the Province of Quebec as its territory.

A Student Branch of the Institute at Vanderbilt University, Nashville, Tenn., was authorized, upon request, approved by the committee on Student Branches.

The board confirmed the appointment by the president of P. H. Chase as a member of the Lamme Medal committee for the unexpired term, ending July 31, 1944, of R. N. Conwell, resigned.

T. H. Morgan and I. Melville Stein were reappointed the representatives of the Institute on the Council of the American Association for the Advancement of Science for the calendar year 1943. John C. Parker was reappointed AIEE representative on the Hoover Medal board of award, for the term of six years beginning in May 1943.

Upon recommendation of the committee on planning and co-ordination, actions were taken affecting members and enrolled students in the armed services or the Merchant Marine, as announced elsewhere in this issue.

Upon recommendation adopted at a conference of the president and vice-presidents concerning District activities, the board gave the Districts the privilege of adding to their executive committees a third representative of each Section, to be selected by the Section, and authorized the regular traveling-expense allowance for three trips a year from each Section to the District executive-committee meetings.

Other actions by the board included the following:

Executive committee actions on applications were reported and confirmed: As of November 23, 1942, 3 applicants were transferred to the grade of Fellow, 45 applicants transferred, 16 elected, and 1 reinstated to the grade of Member; 66 applicants were elected to the grade of Associate; 558 students were enrolled. As of December 21, 1942, 4 applicants were transferred to the grade of Fellow, 13 applicants transferred, 14 elected, and 1 reinstated to the grade of Member; 74 applicants were elected to the grade of Associate; 317 students were enrolled.

Reports of meetings of the board of examiners held November 19 and December 17, 1942, and January 21, 1943, were presented and approved. Upon recommendation of the board of examiners, the following actions were taken: 5 applicants were transferred to the grade of Fellow; 22 applicants were transferred, and 23 were elected to the grade of Member; 126 applicants were elected to the grade of Associate; 242 students were enrolled.

Minutes of the meeting of the board of directors held October 23, 1942, were approved.

Monthly disbursements were reported by the finance committee and approved by the board, as follows: November, $23,402.39; December, $21,224.74; and January, $22,899.89.

Upon recommendation of the standards committee, the board approved the appointment of the following AIEE representatives: Ray W. Ager, J. F. Calvert, and E. E. Piepho on the Sectional Committee C68, "Sphere-Gap Standardization" (succeeding E. J. Rutan and D. F. Miner, resigned, and C. F. Harding, deceased); C. B. Hathaway, R. S. Elberty, and Harry H. Angel on the Sectional Committee C-6, "Rotation, Connections, and Terminal Markings for Electric-Power Apparatus" (replacing two former representatives who retired and one who transferred to a new field of activity).

Those present were:

President—H. S. Osborne, New York, N. Y.
Past Presidents—David C. Prince, Schenectady, N. Y.; R. W. Sorensen, Pasadena, Calif.
Vice-Presidents—A. G. Dewars, Minneapolis, Minn.; J. Elmer Housley, Alcoa, Tenn.; C. R. Jones, New York, N. Y.; E. T. Mahood, Kansas City, Mo.; K. B. McEachron, Pittsfield, Mass.; C. A. Price, Hamilton, Ont.; E. W. Schilling, Bozeman, Mont.; Walter C. Smith, San Francisco, Calif.
Directors—T. F. Barton, New York, N. Y.; M. S. Coover, Ames, Iowa; Mark Eldredge, Washington, D. C.; C. M. Laffoon, East Pittsburgh, Pa.; T. G. LeClair, Chicago, Ill.; W. B. Morton, Philadelphia, Pa.; W. Ralph Smith, Newark, N. J.; R. G. Warner, New Haven, Conn.
National Treasurer—W. I. Slichter, New York, N. Y.
National Secretary—H. H. Henline, New York, N. Y.
Present by invitation during discussion of various matters—Chairman John C. Parker of the committee on co-operation with war agencies; Chairman Robin Beach of the committee on education, and W. J. Gilson and M. J. McHenry of Toronto.

Official Nominees Announced for 1943–44

Nevin E. Funk, vice-president in charge of engineering, Philadelphia Electric Company, Philadelphia, Pa., was nominated for the AIEE presidency for the year 1943–44 by the national nominating committee at its meeting in New York, N. Y., January 27, 1943. Others named on the official ticket of candidates for the Institute offices that will become vacant August 1, 1943, are:

For Vice-Presidents

W. E. Wickenden, president, Case School of Applied Science, Cleveland, Ohio (Middle Eastern District, number 2).

C. W. Ricker, professor and head of school of electrical engineering, Tulane University, New Orleans, La. (Southern District, number 4).

L. A. Bingham, assistant professor of electrical engineering, University of Nebraska, Lincoln, Nebr. (North Central District, number 6).

J. M. Gaylord, chief electrical engineer, Metropolitan Water District of Southern California, Los Angeles, Calif. (Pacific District, number 8).

W. J. Gilson, general manager, Eastern Power Devices, Ltd., Toronto, Ont. (Canada District, number 10).

For Directors

C. M. Laffoon, engineering manager, a-c generator engineering department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

C. W. Mier, engineer, Southwestern Bell Telephone Company, Dallas, Texas.

S. H. Mortensen, chief electrical engineer, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

For National Treasurer

W. I. Slichter, professor emeritus of electrical engineering, Columbia University, New York, N. Y.

The nominating committee, in accordance with the constitution and bylaws, consists of 15 members, one selected by the executive committee of each of the 10 geographical Districts, and five selected by the board of directors from its own membership.

The following members of the committee were present at the meeting:

A. G. Conrad, New Haven, Conn.; M. S. Coover, Ames, Iowa; Mark Eldredge, Washington, D. C.; F. F. Evenson, San Diego, Calif.; A. H. Frampton, Toronto, Ont. (alternate); V. P. Hessler, Lawrence, Kans.; C. R. Jones, New York, N. Y.; T. G. LeClair, Chicago, Ill.; E. T. Mahood, Kansas City, Mo.; E. B. Paine, Urbana, Ill.; Hubert Sharp, Denver, Colo.; A. LeRoy Taylor, Salt Lake City, Utah (Chairman); B. Van Ness, Jr., Baltimore, Md.; Stanley Warth, Jacksonville, Fla.; C. C. Whipple, Brooklyn, N. Y.; and H. H. Henline, secretary of the committee.

The constitution and bylaws of the Institute require publication in the March issue of *Electrical Engineering* of the nominations made by the national nominating committee. Provision is made for independent nominations as indicated in the following excerpts from the constitution and bylaws:

Constitution

Sec. 31. Independent nominations may be made by a petition of twenty-five (25) or more members sent to the national secretary when and as provided in the bylaws; such petitions for the nomination of vice-presidents shall be signed only by members within the District concerned.

Bylaws

Sec. 23. Petitions proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with article VI, section 31 (Constitution), must be received by the secretary of the national nominating committee not later than March 25 of each year, to be placed before that committee for the inclusion in the ballot of such candidates as are eligible.

On the ballot prepared by the national nominating committee in accordance with article VI of the Constitution and sent by the national secretary to all qualified voters during the first week in April of each year, the names of the candidates shall be grouped alphabetically under the name of the office for which each is a candidate.

BIOGRAPHICAL SKETCHES OF NOMINEES

To enable those Institute members not personally acquainted with the nominees to learn something about their engineering careers and their qualifications for the Institute offices to which they have been nominated, brief biographical sketches are included in the "Personal" columns of this issue.

Members in Services May Choose "Inactive" Status

The AIEE board of directors voted at its meeting on January 28, 1943, to extend to all members and enrolled students in the armed forces or the merchant marine of the United States the option of continuing their connection with the Institute in the normal manner or of being placed in an inactive status.

The provisions for members are:

Every member who enters the armed services or merchant marine shall have the option of continuing to pay dues as an active member, and having all publications sent to his permanent address; or of being an inactive member, without payment of dues and without receiving regular publications. Such inactive members will be expected to resume active membership and payment of dues within three months after their severance from war service, with the same status in all respects as existed at the time of entering the service.

Upon notification, Institute headquarters will arrange immediately for "inactive" membership status of members in service, with the understanding that reinstatement, without any formalities, can be effected within three months after severance from war service, as explained in the above resolution.

Enrolled students in the armed forces or the merchant marine are given the option of continuing student enrollment during the

war service, if desired, as explained below:

Upon payment of the annual enrollment fee of $3.00 when renewal notice is issued by headquarters *in April;* publications to be sent to the permanent mailing address.

By requesting an "inactive" student enrollment status without payments of the annual fee and without publication privileges.

Under either of these conditions, enrolled students will have, upon severance from war service, the same status as if they were then college students or had been graduated from college on that date, depending on whether or not they continue their education. This policy is to be in effect for a period of two years.

These provisions are applicable to students whose terms of enrollment normally would expire on April 30, 1943, and who are in the armed forces or the merchant marine before that date, as well as to those whose normal enrollment continues beyond May 1, 1943.

Report of Committee on Co-operation With War Agencies

At the request of President H. S. Osborne, chairman John C. Parker of the AIEE special committee on co-operation with war agencies reported on the activities and accomplishments of that committee at the January 28 meeting of the Institute's board of directors. One of the most conspicuous services rendered by the committee so far has been in connection with the obtaining of technical specialists for the armed services. In addition, special subcommittees have been appointed to assist in collecting information pertaining to the conservation of materials; to act in an advisory capacity on allocation of technical man power; and to assist the Signal Corps in establishing a reference library. Most recently, a subcommittee has been appointed to study the use of silver as a substitute for copper.

In the procurement of technical specialists, the committee rendered assistance to a joint Army and Navy Procurement Committee in obtaining a certain number of engineers, between the ages of 52 and 56, to meet exceedingly stiff specifications for highly specialized work, such men to receive commissions ranging from lieutenant commander to captain in the Navy and corresponding commissions in the Army. Largely through the efforts of C. H. Sanderson, secretary of the commitee, in collaboration with the AIEE Sections, 628 names of men who seem to qualify for the particular work involved have been turned over to the Procurement Committee. More recently, a request, referred to the Institute by the Honorable Herbert Hoover, was received from the United States Marine Corps for assistance in obtaining a thousand or more electrical engineers between the ages of 22 and 42 years, to be commissioned as officers for active duty in specialized work after a period of training. Arrangements have been made to circularize about 25 per cent of the AIEE membership, calling attention to this request. The training involved will afford an opportunity for obtaining a graduate course in electronics that will be useful after the war. Arrangements were made to circularize the member companies of the Association of Edison Illuminating Companies, through their top executives, and some members of the National Electrical Manufacturers Association, soliciting their sympathetic attitude.

A subcommittee under chairmanship of H. M. MacDougal (A '40) senior industrialist, salvage section, War Production Board, Washington, D. C., has done a most effective piece of work in collecting and distributing information pertaining to the conservation of materials and supplementing it from time to time. This material is proving useful in connection with meetings on this subject which AIEE Sections have been requested to arrange.

W. A. Del Mar (F '20) chief engineer, Habirshaw Cable and Wire Division, Phelps Dodge Copper Products Corporation, Yonkers, N. Y., chairman of the subcommittee appointed to assist the Signal Corps to establish a reference library, reported that a substantial amount of material, though perhaps not as much as might be wished in the way of library references, has been presented to the Signal Corps. As there may be further occasion for this committee to render assistance, it was decided that the committee should be continued.

At the October 1942 meeting of the Institute's board of directors, the question of possible service by the Institute to young engineers in securing and disseminating information for their guidance in the problem of deciding where their duty lay in the war effort—whether in school, in industry, or in the war services—was referred to the committee. Doctor Parker reported that a different but effective approach to this problem has eventuated. The War Manpower Commission has a professional and technical division of which Doctor E. C. Elliott, president, Purdue University, Lafayette, Ind., is chairman; Robert E. Doherty (F '39) president, Carnegie Institute of Technology, Pittsburgh, Pa., is chairman of the consultative committee on engineering for that division. This committee has met with Doctor Elliott, and is attempting to formulate recommendations of the deferment from military service of the more earnest, hard working, and competent students, with their more usual type of college work accelerated and intensified in the war effort. Doctor Parker stated that he had considerable hope of developments from Doctor Doherty's work with Doctor Elliott and their reports to WMC chairman Paul V. McNutt, which may resolve some of the conflict between the supply of materials and the requisitioning of man power in the war effort.

In response to a request from the division of conservation and substitution of the War Production Board, a subcommittee of five men has been appointed to study the problem of the use of silver as a substitute for copper in electric equipment and systems. Philip Sporn (F '30) vice-president in charge of engineering, American Gas and Electric Service Corporation, New York, N. Y., has been appointed chairman of that subcommittee.

The complete personnel of the AIEE committee on co-operation with war agencies is as as follows:

John C. Parker, *chairman* (F '12), vice-president, Consolidated Edison Company of New York, New York, N. Y.

C. H. Sanderson, *secretary* (F '18), system planning engineer, Consolidated Edison Company of New York, New York, N. Y.

C. A. Adams (F '13), consulting engineer, Edward G. Budd Manufacturing Company, Philadelphia, Pa.

H. H. Barnes, Jr. (F '13), retired, New York, N. Y.

H. S. Bennion (M '27), vice-president and managing director, Edison Electric Institute, New York, N. Y.

A. W. Copley (F '26), Pacific Coast engineering manager, Westinghouse Electric and Manufacturing Company, San Francisco, Cal.

Gano Dunn (F '12), president, J. G. White Engineering Corporation, New York, N. Y.

W. H. Harrison (F '31) brigadier general, United States Army.

F. B. Jewett (F '12), vice-president, American Telephone and Telegraph Company, New York, N. Y.

Increased Activity Planned by Air Transportation Committee

The AIEE committee on air transportation, at a meeting held during the recent AIEE national technical meeting in New York, N. Y., announced the adoption of a program of increased activity. Technical papers on all phases of air transportation from various members of the aircraft industry are now being encouraged by the committee with the intention of recommending for widespread publication as many as are consistent with wartime restrictions, and restricted publication for others.

Aircraft electrical engineers during the current emergency are working under a considerably greater handicap than are other electrical engineers. Because of the restrictive nature of their work it is difficult for them to prepare papers that can be published. To remedy this situation, the policy described here has been formulated.

Technical papers of general interest are solicited, not only from members of AIEE but from any member of the aircraft industry. These papers will be prepared by the engineer and forwarded to AIEE headquarters for the customary review. In turn they will be passed on to the Bureau of Aeronautics at Washington, D. C., and to the Matériel Center of the Army Air Forces at Dayton, Ohio, for criticism and a decision as to whether they should be restricted.

A paper that is considered to be "restricted" may be released for restricted publication by the National Advisory Committee for Aeronautics in such fashion that its contents will not become known to unfriendly interests. In any event the paper will be recommended for publication and distribution to those whom it most concerns. It is also possible to obtain reasonably wide distribution of important engineering information among engineers of the aircraft industry through restricted meet-

ings. By this means, a group of engineers whose citizenship has been attested can meet and freely discuss papers that have been withheld from open publication. However, this type of meeting probably will require the sanction of local Army and Navy authorities.

To compensate for lack of public discussion of many of the papers in open meetings, strong efforts will be made to obtain written comments by mail. This will result in the dual advantage of more comprehensive criticisms and in the collecting of opinions from different portions of the country which will be beneficial to every engineer in the aircraft industry. Papers considered worthy of publication and not restricted by either government agency will be recommended for presentation at an AIEE technical meeting and subsequent publication in the usual fashion.

Because of the growing resemblance between aircraft electrical systems and utilities and other installations, electrical engineers who are working in this industry have much to gain from association with the AIEE. Problems of control, protection, and design which already have been encountered by the utilities and other engineering interests are applicable on a smaller scale to the electrical systems now being installed in aircraft. For that reason aircraft electrical engineers are urged to increase their interest and contribution to the engineering advances as sponsored by the Institute. (*Chairman, AIEE committee on air transportation.*)

Wartime Changes in Substation Design Discussed

Protection against sabotage and protective lighting of substations, changes in substation design and use of substitute materials caused by the war, and higher loading of existing equipment were the salient points of discussion of the conference on substation designs to meet wartime conditions conducted January 27 during the AIEE national technical meeting.

Precautions against sabotage taken by various companies, according to the discussers, include: increase in the number of special guards; limiting of station entrances to certain points; low-oil-level alarms on transformers and intrusion alarms at unattended and partially attended substations; screened windows; walls around outdoor equipment; inspection of locks; increase in repair crews which are always on call; additional fire-fighting, air-raid, and black-out equipment, and instruction of staff personnel in fire fighting.

Blacking-out of control rooms and substations, shielded and reduced lighting, fence lighting and illumination of approaches to identify possible prowlers and at the same time conceal the guards, and floodlighting which deters sabotage through glare were commented on.

Substitute materials called into use because of the war emergency include the reusing of material which formerly was junked; foundation reinforcements recovered from demolition jobs; wooden transmission-line and substation structures; wooden poles, roof trusses, bridges, and fences instead of steel; precast concrete cone anchors in place of iron anchors; concrete trenches or buried cable to replace steel conduit and pull boxes for control cable covering, and steel conductors in place of copper ones. The speakers pointed out that less reinforced concrete is being used; high-voltage lines in urban sections are being constructed above ground instead of underground as formerly; many equipment foundations are being installed without reinforcements, because of the steel shortage; available structural steel was being refabricated to fill essential requirements, old equipment was being rebuilt and modernized instead of purchasing new equipment; and some companies have installed remote-control equipment on account of the shortage of man power.

Results were presented of studies made of the possibility of loading substation transformers to the fullest extent without shortening their useful life appreciably. Methods were discussed of utilizing available transformer capacity to the utmost and, at the same time, keeping to a minimum the purchase of new transformers.

L. R. Gaty (A '39), Philadelphia Electric Company, Philadelphia, Pa., chairman of the stations subcommittee of the AIEE committee on transmission and distribution presided. Speakers included Harold Cole (M '27), Detroit Edison Company, Detroit, Mich.; C. M. Gilt (F '35), Consolidated Edison Company of New York, New York, N. Y.; H. E. Mahan (A '28), General Electric Company, Schenectady, N. Y.; E. K. Huntington (M '35), Rochester Gas and Electric Corporation, Rochester, N. Y.; H. E. Wulfing (M '23), Commonwealth Edison Company, Chicago, Ill.; P. R. Knapp (F '38), Toledo Edison Company, Toledo, Ohio; L. E. Steere, Potomac Electric Power Company, Washington, D. C.; L. M. Robertson (M '38), Public Service Company of Colorado, Denver, Colo.; Stanley Stokes (F '29), Union Electric Company of Missouri, St. Louis, Mo.; E. V. Sayles (F '38), Commonwealth and Southern Corporation, Jackson, Mich., and L. R. Gaty.

Conference on Military Loads and Postwar Applications

Two formal technical papers and three informal conference presentations comprised the program of the conference on analysis of military loads and postwar applications held during the recent AIEE national technical meeting. W. F. Ogden, Jr., chairman of the AIEE committee on domestic and commercial applications, presided.

W. L. Tadlock (M '37) of the Commonwealth and Southern Corporation, Birmingham, Ala., presented a method of analyzing loads in a war housing project for use in designing a distribution system for supplying such loads, which included water heaters. "The voltage regulation is the factor limiting load on most distribution-system components," said Mr. Tadlock. "For this reason, these components can be designed intelligently only on the basis of the recurrent maximum demands of their associated loads. This paper presents a logical method of determining such load demands."

"The method can be used to advantage in properly interpreting all electric loads which are not fully diversified," declared the author. "Other domestic loads, such as lighting, ranges, and so forth, commercial lighting and power loads, and lighting and power loads in current military establishments could probably be served with the use of materially less strategic materials if their average recurrent maximum demands were better known." In the discussion of this paper, several members from other parts of the United States related their experiences and practices in supplying military establishments.

"Standards of Safety" were discussed by S. B. Williams (M '37) editor of *Electrical World*, New York, N. Y., who covered two principal aspects of the subject: (1) safety to the public, either fire or personal hazard; (2) safety to equipment. Mr. Williams recommended that the basic elements of safety both to life and property be studied for the purpose of developing standards of "unity of safety." He recommended also that in such a study the factors of safety to be applied to the "unity of safety" be determined for various conditions.

Motors are being designed differently now, but, more importantly, both old and new motors are being applied differently, declared J. L. Hamilton (F '21) of the Century Electric Company, St. Louis, Mo., in discussing "Wartime Electric Motors and their Postwar Applications." He called attention to the fact that the recently promulgated rules of the War Production Board specify overloads higher than any considered safe in the past. These overloads, he said, which are based on a hot-spot temperature of 115 degrees centigrade, probably will shorten the life of motor insulation, as compared with operation at 105 degrees centigrade on which previous operating standards are based. Present needs, however, may justify this shortened life.

In discussing the postwar aspects of his subject, Mr. Hamilton said that the United States has been the world's leader for many years and expressed the opinion that it would continue to lead for many years hence. This general statement applies strongly to the manufacture of electrical equipment. He predicted that the inevitable closer relations between nations of the world after the war would influence motor design. He foresaw smaller, lighter motors, with better ventilation. Aluminum and plastics also will find increased applications, and better insulation will be used in the construction of the motors.

Presentation and discussion of two regular AIEE technical papers completed the program:

"Estimating Electric Loads for Military Training Bases, Federal Housing, and Other Wartime Projects,"

H. M. Potts, Bonneville Power Administration, Portland, Ore.

"Rural Electrification Engineering and Electroagricultural Engineering," **M. M. Samuels**, Rural Electrification Administration, St. Louis, Mo.

Both of these papers and the approved discussion thereof will be published subsequently in the *Transactions*.

Defense Lighting Operations Reviewed at Conference

Following the AIEE conference symposium on defense lighting, three of the participants discuss some of the problems. They are, left to right, Captain George J. Stockly, internal security division, Second Service Command of the United States Army; Major R. P. Breckenridge, corps of engineers, camouflage branch, United States Army; and Samuel G. Hibben, director of applied lighting of the Westinghouse Lamp Division.

Results of a year of defense-lighting operations from the utility, military, and traffic-safety points of view were discussed and appraised at the conference on defense lighting, sponsored by the AIEE committee on the production and application of light, held January 26, 1943, during the AIEE national technical meeting. S. G. Hibben, secretary of the committee, presided. Speakers were Tom P. Walker, president of the Council of Electric Operating Companies, Washington, D. C.; Captain G. J. Stockly of the Internal Security Division, Second Service Command, Governors Island, N. Y.; Major R. P. Breckenridge, Corps of Engineers, Camouflage Branch, United States Army, Fort Belvoir, Va.; and Richard E. Simpson, chairman of the dim-out consulting committee, State Defense Council, Hartford, Conn.

Speaking for the electrical utility industry, Mr. Walker said, "Curtailment of electric power is not now necessary in any section of the United States because of the lack of capacity to supply all war loads as well as civilian needs . . . . From the best estimates which can be made at this time, and discounting the probability of major accidents or sabotage, there is a very good chance that electric power will continue to be available for all war agencies without curtailment of civilian use."

Speaking of the relationship of the electrical utility companies to conditions of black-out and dim-out, Mr. Walker pointed out that the utilities in co-operation with the Office of Civilian Defense have had a large part in the perfection of these forms of defense lighting, not alone through the blacking out of their own facilities, but through their assistance in designing and demonstrating black-out devices. As black-outs are only temporary, their effect on the earnings of power companies is inconsequential, Mr. Walker said. It is the sudden dumping of about 60 per cent of a station load within a few minutes that has created a problem for powerhouses in black-out areas. Utility companies, in compliance with plans developed by government agencies, have made large expenditures and instituted comprehensive training programs in order to protect important generating and substation facilities against damage from air raids and sabotage. Dim-out regulations, too, Mr. Walker said, have required large expenditures of money and use of some critical materials on the part of electrical utilities. He pointed out that such sacrifices are made in the realization that skyglow from undimmed areas along the coasts of the United States provide a background that silhouettes ships and makes them a perfect target for the enemy. He stressed the necessity of educating the public to the efficacy of the dim-out, which has been criticized as a safety hazard.

Captain Stockly, speaking from the military viewpoint on wartime control of lighting for passive defense, pointed out that both the black-out and the dim-out are effective means of passive defense. He mentioned that it is believed that black-outs can be accomplished more easily in dim-out areas than in areas using maximum lighting. Enumerating the causes for the unpopularity of the dim-out as loss of business, loss of life, and annoyance with the whole procedure, he stated that there is no doubt about the importance of the dim-out in coastal areas as a protective measure to prevent skyglow.

Major Breckenridge, relating the use of illumination to camouflage and concealment, talked on the problems in that field and called upon electrical engineers to contribute any ideas they might have for coping with the problem of camouflage to the chief of engineers, War Department, Washington, D. C.

The effects of wartime dim-out on public safety was the topic of Mr. Simpson's talk. He cited statistics regarding traffic accidents in various cities throughout the state of Connecticut on streets with old lighting and on streets with improved lighting, and contrasted these with similar data on traffic accidents before and after the dim-out was instituted.

Speaking of surveys made of streets in Hartford, Bridgeport, and New Haven, where street lighting was modernized prior to the dim-out on certain thoroughfares and not on others, he said that illumination was raised from an average of 0.2 lumen per square foot to 0.7 on approximately 50 miles of streets. Over a period of several years, data showed a reduction of 68 per cent in the number of night fatalities on relighted streets and a 52.1 per cent increase on streets where old lighting was still in use. Since dim-out regulations have been in effect, the over-all reduction in night visibility has sunk below the level which previous experience proved necessary for reasonable public safety under normal conditions. Mr. Simpson pointed out that there was a 77 per cent decrease in day fatalities in Bridgeport and New Haven after the dim-out, but an increase of eight per cent in the number of night fatalities. As dim-out regulations now in force are more stringent and cover more territory than former regulations, he said that improvement in the night traffic safety in Connecticut can hardly be expected.

Following the talks, the audience participated in informal discussion.

Conference on Emergency Loading of Transmission Systems

Maximum allowable loads that can be carried by power transmission systems was the general subject of a Monday-evening conference held during the recent AIEE national technical meeting. Edwin Hansson, member of the AIEE committee on power transmission and distribution, presided.

Rolf Selquist (A '25), of the Copperweld Steel Company, Glassport, Pa., H. R. Stewart (M '39), New England Power Service Company, Boston, Mass., and G. W. Stickley (A '29), Aluminum Company of America, New Kensington, Pa., described the annealing characteristics of Copperweld, copper, and aluminum transmission-line conductors, respectively. They covered the annealing produced by operation at certain temperatures and the effects of such annealing on the strength and life of the conductors.

Normal and emergency ratings established by the Commonwealth Edison Com-

pany, Chicago, Ill., for triple-braid and bare copper conductors were presented by M. S. Oldacre (M '42) of that company.

L. F. Hickernell (F '34), Anaconda Wire and Cable Company, Hastings-on-Hudson N. Y., called attention to the lack of uniformity in current ratings for overhead conductors and pointed out that these ratings vary primarily because they are not based upon the same conditions or assumptions. He then presented the ratings recommended by the Anaconda Company for hard drawn and hollow I-beam copper conductors. He also presented test data which indicated that the temperatures reached in connectors of various sorts in general are lower than those reached in the cable itself.

Myron Zucker (M '36) of the Jam Handy Organization, Detroit, Mich. (on leave from the Detroit Edison Company) presented the results of a study of overhead line-wire ratings conducted while he was associated with the latter company. "The major problems in rating overhead wires according to thermal limits," Mr. Zucker declared, "are (1) how materials lose their strength and (2) how hot wires become when various currents are passed through them. Much scattered work has been done on these subjects in the last 20 years, but results have either been inconclusive or, in many cases, contradictory. This discussion brings together data from many sources, adds certain data, and outlines the general problem.

"Omitting the obvious discussion of efficiency and voltage drop, let us say that the rating of overhead wires must be such that there shall be no appreciable weakening of the conductor material and clearances at the higher temperatures of operation must be ample." Mr. Zucker presented data on two specific phases of the general problem: (1) permissible temperatures without damaging the strength of the wire, causing undue deterioration of the covering, or reducing clearances below reasonable values; (2) temperatures that the wire will attain under various conditions of weather and under normal and emergency operation.

Conference Chairman Hansson states that the discussions at this conference point to the following conclusions:

1. The opinions as to the effects of time and temperature on the annealing of copper vary.

2. Methods for determining these effects without destroying the sample have been developed.

3. Once the percentage loss of strength to be tolerated has been determined, the current density that will result in this loss in any given time can be determined with reasonable accuracy.

4. High ambient temperatures coincident with very low wind velocities occur only a very small percentage of the time.

5. Established ground clearances rather than annealing may be the limiting factor in some cases.

6. In new lines, the conductor temperature may limit the loading. In lines built 10 to 20 or 30 years ago, this is not always the case. On practically all existing lines the conductor clamps are of magnetic material, and high current densities may produce dangerous annealing of the conductor where it is subjected to the maximum mechanical stresses. In such a case the conductor in the spans may have been comparatively cool and yet numerous breaks will be experienced some time after the maximum load was applied.

Training of Engineers for Industry Urged at Education Conference

The need of a program for training engineers for industry, comparable to the specialized programs of the Army and Navy, was agreed upon unanimously by the conference on wartime engineering education January 27 during the AIEE national technical meeting in New York, N. Y. Action taken at the conference culminated in a letter to the War Manpower Commission, signed by AIEE President H. S. Osborne, urging such a program.

Robin Beach (F '35), Polytechnic Institute of Brooklyn, Brooklyn, N. Y., chairman of the education committee, who conducted the conference, read an outline for the continued training of engineers to aid the war industries in carrying on their part in the war effort. No such program had yet been formulated by the War Manpower Commission for training engineers for industry on a basis comparable with the specialized training programs announced by the Army and Navy (see lead articles in this issue).

Scheduled speakers who presented various views on the subject included J. W. Barker (F '30), special assistant to the Secretary of the Navy, Washington, D. C.; H. T. Heald, president of the Society for the Promotion of Engineering Education; Colonel Herman Beukema, director of the specialized training division of the Army, Arlington, Va.; S. H. Mortensen (F '20), Allis-Chalmers Manufacturing Company, Milwaukee, Wis., A. C. Monteith (M '40), Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., and G. R. Brown (M '36), Western Electric Company, Kearny, N. J.

W. R. McGaffrey of the National Canadian Standards Institute described the well-organized plans by which the Canadian government controls the development of its technical manpower, its various phases of training, and the allocations of its well-trained engineers and technicians, so as to provide adequately for industry's needs, as well as those of the military services.

Discussion centered on the needs in industry for a continuing flow of engineers to carry on the development and manufacture of the instrumentalities of war to the highest possible degree. At the conclusion of the discussion period, a motion was offered and passed unanimously recommending that the AIEE board of directors consider sending a communication to the government officials at Washington, D. C., expressing grave concern that no program for the training of engineers for industry, comparable with the specialized programs of the Army and Navy, has been announced and urging that immediate at-

Train Engineers for Industry

Communication from H. S. Osborne, AIEE President, to Paul V. McNutt, chairman of the War Manpower Commission, Washington, D. C., urging establishment of a national program for the training of engineers for industry:

Mr. Paul V. McNutt
Chairman, War Manpower Commission
Washington, D. C.

Dear Sir:

Programs for specialized training to meet the technical manpower needs of the Army and Navy have been presented to the members of the AIEE at its national technical meeting now in session.

We are much concerned, because no corresponding training for industry has been announced. Such a program should be set up and announced at the earliest possible moment in order that a proper share of the nation's technical man power be allocated to the development and manufacture of war equipment.

New and improved war machinery ever superior to that of the enemy must be continuously developed and produced in the shortest possible time. We believe this can be done only by men having the broadest engineering education obtainable in an accelerated program specifically adapted to this purpose.

The executive committee of the Institute board of directors has requested me to send you these expressions of opinion and advise you that the Institute stands ready to aid in setting up a program for the training of engineers allocated to industry if this would be helpful.

Very truly yours,
(Signed) H. S. Osborne,
President, AIEE

January 29, 1943

tention be given to formulating an appropriate program and to putting it into operation. The board subsequently authorized the sending of such a communication (see text of letter in an accompanying item). (*Robin Beach, chairman, AIEE committee on education.*)

Wartime Relay Problems Subject of Relay Conference Session

Relay testing and maintenance, and wartime relay problems were the chief subjects of discussion at the relay conference held January 25 during the AIEE national technical meeting in New York, N. Y. A summary was presented by the working group on relay testing of the relay-testing questionnaires that had been circulated to operating companies. The questionnaires covered acceptance, installation, calibration, and routine tests. H. F. Lindemuth (M '41), Consolidated Edison Company of New York, Inc., New York, N. Y., introduced the subject and stated that the survey had been instigated because of the wide differences in practices and nomenclature used by various companies in their relay testing. It was thought that a review of the subject would bring out reasons for the differences and initiate many improvements.

Acceptance and installation tests were presented by S. C. Leyland (A '40), Westinghouse Electric and Manufacturing Company, Newark, N. J. These, respectively, are tests given new relays before installation, to determine their condition on receipt, and those made in the field, to insure proper operation of the protective system before the relays are placed in service. Calibration tests were discussed by J. C. Bowman (A '40), Public Service Electric and Gas Company, Newark, N. J. These are the more extensive periodic tests to determine that all settings have been maintained and that the relay is in good mechanical condition. Routine tests, inspection, and trouble checks were explained by C. A. Muller (M '36), American Gas and Electric Service Corporation, New York, N. Y. The routine tests cover checks made between calibration tests as over-all checks on the relay and breaker operation. The matter of reports and a summary of the questionnaire was presented by J. H. Oliver (M '41), General Electric Company, Philadelphia, Pa., sponsor of the working group.

The discussions of this report centered largely around the feasibility of combining or eliminating some of the tests and around the more important phases of relay testing. Several discussers were in favor of separate acceptance and installation tests, because the condition of the relay as received was determined, the acceptance tests can be done in a laboratory where adequate equipment and personnel are available, and cutting into service operations would not be delayed by relay testing. Others had found quite satisfactory results from making the acceptance tests in the field as part of the installation test and preferred this arrangement, because on widely spread systems only a single trip was required to the territory involved, because of the inconvenience of taking to the laboratory relays mounted on factory-built switchgear, or because of lack of economic justification for the separate acceptance test. One discusser reported that in one instance where separate tests had formerly been made, a study had shown them to be unjustified economically; hence they had been discontinued, with highly satisfactory results.

The importance of checking the trip circuit completely as part of the relay testing or by supervision was emphasized. Methods employed for over-all check of external wiring were described and its importance was emphasized, since a large proportion of difficulties occur external to the relay.

L. F. Kennedy (M '39), General Electric Company, Schenectady, N. Y., sponsor of the working group on wartime relay problems, reported on experiences with relays under actual combat conditions in foreign countries, and on other wartime relay problems, such as tap lines and interconnections. (*E. L. Harder, chairman, AIEE relay subcommittee.*)

Wartime Guide Discussed at Conference on Industrial-Distribution

A proposed wartime guide for industrial electric-power distribution systems, comprising a preliminary report of some 50 printed pages prepared by the AIEE committee on industrial power applications, was the only item on the agenda of the conference on industrial power distribution held during the recent AIEE national technical meeting. J. J. Orr, chairman of the committee, presided.

This guide is one of several now being prepared by various AIEE committees on a variety of subjects, all looking toward making the maximum possible use of existing equipment and holding to a minimum the amount of critical materials to be used in the construction of new equipment. Characterized by Technical Program Committee Chairman P. L. Alger as one of the best of the group prepared thus far, this proposed guide is intended to promote the use of sound engineering principles in the design and selection of equipment for industrial distribution systems. It is divided into nine sections each covering a specific aspect of the general subject. The complete plant distribution system is covered, including feeders and circuits and the application of all transformation, switching, and protective equipment. The preliminary report is the foundation from which the committee expects to prepare a guide book for later publication.

Discussion of the proposed guide was carried out on a section-by-section basis. Electrical engineers from industrial plants, equipment manufacturers, and power companies participated. In general, the discussion emphasized the need and value of such a guide to industrial power men, but also indicated a divergence of opinion on certain points. This discussion, declared Mr. Orr in his opening remarks, "will be used by the committee in revamping it [the guide] and producing it in what we hope will be a permanent valuable contribution to the literature of the Institute and the profession."

Increased Loading Discussed at Power-Generation Conference

"How to get the most out of present equipment" was the underlying theme of the conference on power-generating equipment held during the recent AIEE national technical meeting. A. C. Monteith, chairman of the AIEE committee on power generation, presided.

The equipment manufacturers' views on the problem were summarized in a report "Emergency Measures to Increase Output of Generating Equipment," presented by C. M. Laffoon, chairman of a subcommittee of the main committee on power generation. "It is reasonable to conclude," the report states, "that the output of any machine can be increased a small percentage above its specification value, but it must be fully appreciated that there is not only an unknown reduction in winding life, but all other characteristics and mechanical stress which are a function of loading are changed or increased. Any contemplated increase in the output of a generator necessitates a complete check on the limitation of all associated main equipment, such as boilers, prime movers, switchgear and transformers, auxiliary apparatus such as pumps, blowers, exciters, relays, and control equipment, and on the entire distribution system with its connected load.

"In view of the fact that so many essential factors are involved with a particular machine and its associated equipment, general recommendations concerning increased output can only be made in a very few specific instances. In all cases it is necessary and essential that each unit under consideration be checked carefully with the manufacturer in determining its emergency loading capability."

The report closed with the following conclusions and recommendations:

1. Some additional output can be obtained by taking advantage of the temperature margin that may exist in specific units. This may necessitate small changes in generated voltage and operation of each unit at the power factor most favorable for increased output.

2. Generators with class *B* insulation and class *A* temperature guarantees for both rotor and stator can be operated continuously at ratings (approximately 115 per cent) which result in recognized class *B* temperatures. The life expectancy of the windings will be decreased to that corresponding to the higher temperature.

3. Increased generator output at temperatures in excess of the temperature limits recognized for the class of insulation and its application results in an appreciable decrease in the life expectancy of the windings. This method of obtaining additional output for continuous or short-time loadings with its resultant decrease in life expectancy of the insulation, may be justified economically under specific conditions.

4. Increased output can be and in some cases is being obtained by taking advantage of low ambient temperatures of the cooling medium. Although the specification values of total temperatures are not exceeded, the life expectancy is decreased due to the increased differential expansion and contraction of the winding copper with respect to the surrounding iron.

5. In most cases, the output of hydrogen-cooled generators can be increased approximately 15 per cent by increasing the average pressures of the cooling gas from 1/2 pound to 15 pounds gauge. Such increase in gas pressures may require changes in the auxiliary equipment for supplying oil to the shaft gland seals and for the operation of the gas control.

6. In view of the fact that so many factors are involved in determining the available increase in output of large generating equipment, and any increase in loading must be carefully checked in relation to other associated main equipment, auxiliary apparatus, and the distribution system with its connected load, it is recommended that each case be checked with the respective suppliers. After obtaining and reviewing all essential data, the user and supplier should mutually agree on the rating capabilities of each particular unit, with full realization that the increase in output will result in a shorter life expectancy and affects other important characteristics of the unit.

7. It is recommended that the user follow the supplier's recommended procedure for starting up and shutting down, and normal operation of a particular unit for which an increase in output is mutually agreed on in order to reduce the mechanical deterioration of the insulation due to differential expansion and contraction effects.

A second report "Emergency Measures to Increase Output of Generating Systems," presented by R. P. Crippen, chairman of another subcommittee of the main committee, the answers to a questionnaire submitted to leading power companies were summarized. "The replies received," states the report, "appear to indicate a worthwhile reservoir of generating capacity still to be tapped in some areas by proper application of loading beyond name-plate rating; reduction in spinning reserves through adoption of short-time emergency ratings and a small reduction in service reliability; and a review of all possibilities for removing bottlenecks which at present limit capacity of particular equipment or lines."

Specific subjects reported on include: maintenance, loading limits on equipment, power-factor correction, interconnected operation, effect of voltage and frequency on system loading, personnel problems, rebuilding and rehabilitation, and maintenance and repair methods. Characterizing his presentation as a "preliminary report" Mr. Crippen said that his subcommittee's objective is to prepare a report that will represent a consensus of the industry, and he invited suggestions and criticisms on any of the subjects covered.

Following the presentation of these two reports, there was general discussion from the floor in which power system and manufacturers' representatives from widely separated parts of the United States discussed various aspects of the report and outlined practices followed by their companies.

Land-Transportation Conference

Of the four papers presented at the conference on land transportation held January 26 during the AIEE national technical meeting, three have a direct bearing on the war effort. P. H. Hatch, secretary of the AIEE committee on land transportation, presided.

A paper by Durval Muylaert, Sorocabana Railway, Brazil, described the electrification of that railway. The paper pointed out that labor in Brazil is paid about one sixth of the United States rate; coal in Brazil brings about $12 per ton, when it can be obtained at all; and water power is abundant. These are ideal conditions for railroad electrification, and the situation offers a market for American products to be exchanged for commodities produced in Brazil which will be needed increasingly for the world's war larder.

Train communication between locomotive and caboose or between train and wayside station was discussed by L. O. Grondahl (M '42) and P. N. Bossart, both with the Union Switch and Signal Company, Swissvale, Pa. This form of communication materially speeds up train operation and requires little strategic material, particularly when used in yards where one-way communication from the yard office to the locomotives may be sufficient.

These two conference papers have been approved for formal presentation at a later AIEE technical meeting, and subsequent publication in *Transactions*.

The third paper presented, "Keep Them Rolling" (AIEE *Transactions*, 1943, March section, pages 107–12) by J. W. Teker (A '31), General Electric Company, Erie, Pa., covers the maintenance of electric equipment on electric and Diesel-electric locomotives. It offers many valuable suggestions on preventive maintenance to avoid failure and unnecessary use of material.

A paper presented by H. C. Wilcox, *Railway Mechanical Engineer*, and A. G. Oehler (F '26), *Railway Age*, both of New York, N. Y., entitled "Factors Involved in the Selection of Railroad Motive Power," aroused considerable controversy. It is not possible to write a formula that can be used to determine the type of motive power needed for a specific application; but it was suggested that, by co-ordinating the efforts of the AIEE group with those of other associations interested in the subject, the procedure proposed for selecting motive power might be developed to a point where it would be of real value to the railroads. (*A. G. Oehler, chairman, AIEE committee on land transportation.*)

Guide for Selecting Motors Discussed at January Meeting

The Proposed Guide for the Selection of Electric Motors and Motor Controllers was discussed at a conference January 25 during the AIEE national technical meeting, with special emphasis on wartime needs and regulations. F. E. Harrell, chairman of the AIEE committee on electrical machinery, and J. J. Orr, chairman of the committee on industrial power applications, presided jointly.

Mr. Orr, opening the discussion, pointed out that, because of the acute shortage of copper and other critical materials, the War Production Board had urged the AIEE to alter its standards for electric motors and motor controllers in order to conserve these materials. AIEE was reluctant to change its standards hastily but co-operated with the WPB by furnishing an emergency guide in the use of existing standards under the present emergency conditions. This guide has been officially recognized by the WPB in its order *L*221.

L. F. Adams (F '42), General Electric Company, Schenectady, N. Y., declared that the proposed guide loses sight of one thing, that is, control of the motors already in use. Manufacturers should manufacture and sell on the same basis as before, he stated, but they should not control the operation of motors already in use. The greatest use in both life and efficiency of the motor must be considered, and only the user can assume responsibility for this. Therefore the proposed guide should give more consideration to what the user can do with his motor.

Quentin Graham (A '39), Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., discussing the effect on motor operating performance and life resulting from loading electric motors in accordance with the proposed guide, indicated that, for about half of all motors included, the existing steps between standard ratings are greater than the proposed emergency increases, and no overload is involved. He estimated that available information would seem to indicate at least 10 and possibly 15 years' life for the average motor.

P. B. Harwood (F '42), Cutler-Hammer, Inc., Milwaukee, Wis., explained the effect of loading motors and control in accordance with the proposed guide on heating, arc rupturing, and contact life of controllers.

L. A. Umansky (M '27), General Electric Company, Schenectady, N. Y., stated that it is important to estimate the horsepower requirement accurately and to realize that a great deal of copper saving can be accomplished in selection of the proper size of motor and in the layout of the distribution system, as well as in the manufacture of the motor.

S. H. Mortensen (F '20), Allis-Chalmers Manufacturing Company, Milwaukee, Wis., read a discussion prepared by R. H. Smith (M '36) Reliance Electric and Engineering Company, Cleveland, Ohio, on the effect of motor-speed selection, mechanical protection, and enclosure on quantity of critical materials required in electric motors.

Order *L*221 makes it difficult to keep a motor running continuously when the user must get rid of all extra machines, B. M. Werly (M '34) Eastman Kodak Company, Rochester, N. Y., pointed out. Limits also are placed on the procurement of copper wire because of the shortage of copper. What can be put in a motor's place while the motor is being repaired? The trend is away from the open-type motor, which, he stated, is the only one adaptable to the proposed changes. He declared that the 40 degrees centigrade standard in motors and controllers should not be changed.

H. L. Wilcox (M '37), Electric Control-

ler and Manufacturing Company, Cleveland, Ohio, said that the purpose of the proposed guide should be to educate the user and to give him concrete evidence of what he can do without getting into trouble. He must be educated to select and install the motor properly. A motor of minimum required rating may be selected for a given application if the motor is well designed and efficient in every way, but in that event control must be taken from the operators, and automatic precise control is needed.

Penalizing the user of electric motors for poor power-factor correction will bring about improvement and get rid of overmotored machines, according to R. E. Stroppel (A '34), Tool Steel Gear and Pinion Company, Cincinnati, Ohio. A well-rounded maintenance program will conserve metal best, he stated.

P. L. Alger (F '30), General Electric Company, Schenectady, N. Y., and M. S. Oldacre (M '42), Commonwealth Edison Company, Chicago, Ill., agreed that education was the important thing in the selection of motors and controllers. Mr. Alger cautioned: "The guide is a step in the right direction, but does not change our values." Mr. Oldacre declared that "the report misses the point so far in not settling the question of educating the user to apply the motor. Some consider that this point should be dealt with further before the guide is published."

Carroll Stansbury (F '38) reported for Lieutenant J. M. Fluke (A '37), Bureau of Ships, Navy Department, Washington, D. C., on the Bureau's experience in selecting electric motors and controllers, and John Gammell (A '38) of the War Production Board, Washington, D. C., advised engineers to send suggestions to the WPB regarding modification of orders and new ideas on the subject.

Mr. Orr, closing the discussion, commented that some industries need education on overloading motors and others do not. "The value of the guide," he summarized, "is to back up the engineers and to make the buying public awake to copper and other shortages."

Emergency Ratings of Cables Discussed at January Conference

The theme of the conference on emergency rating of power cables held during the recent AIEE national technical meeting was clearly followed in the nine papers that were presented. Although there was a similarity in some of the views expressed by several authors, this was thought to be wholesome as it emphasized or strengthened the viewpoint. It was brought out that some of the largest power companies have raised their normal operating temperatures on power cables above industry standards from five to ten degrees centigrade, after having conducted investigations on the deterioration of insulation, the mechanical effects of such increases, recognition of an increase in the rate of cable failure, and, therefore, a shortening of the life of the cable. In addition, emergency temperatures have been set up which permit higher loads to be carried under limited conditions such as one, five, or ten times per year, depending upon the increase in temperature allowed.

There does not seem to be a necessity in general to set up additionally higher temperatures for war purposes, as the contemplated loads did not materialize; this was due in part to the spreading out of the power load over a 24-hour period, resulting in an increase in load factor, but not in maximum peak load. In addition, some industries had a decrease in their normal type of business with an increase in war business and, therefore, did not have to call upon the utilities for additional power. The general consensus of opinion as expressed at the conference is that it is safe to operate impregnated-paper-insulated cables at emergency loadings equivalent to operating temperatures 10 to 20 degrees centigrade above present normal temperatures for short and infrequent periods without taking too much life out of the cable.

G. L. Carlisle of the War Production Board explained the conditions under which the power branch of the War Production Board reviews applications for the purchase of power cables, citing the factors that must be satisfied as to the ability of utility to meet the situation before permission is granted to purchase.

Power company practices and experiences on emergency loading of cables were presented by the following speakers from widely separated parts of the United States: H. W. Collins (A '22) Detroit Edison Company, Detroit, Mich.; H. L. Davis, Jr. (A '27) Philadelphia Electric Company, Philadelphia, Pa.; G. E. Dean (A '28), Public Service Electric and Gas Company, Newark, N. J.; C. T. Hatcher (M '37), Consolidated Edison Company of New York, New York, N. Y.; E. W. Oesterrich (F '42), Duquesne Light Company, Pittsburgh, Pa.; Herman Halperin (M '26), Commonwealth Edison Company, Chicago, Ill.

Manufacturers views and recommendations were presented by W. A. Del Mar (F '20), of the Habirshaw Cable and Wire Division, Phelps Dodge Copper Products Corporation, Yonkers, N. Y., and G. B. Shanklin (M '29), of the General Electric Company, Schenectady, N. Y. (*R. J. Wiseman, chairman, cable working group, AIEE committee on power transmission and distribution.*)

Protective Devices Discussed at Three Sessions of Meeting

Relays and associated equipment, relaying of transmission lines, and circuit breakers and switches were the subjects of discussion at the three technical sessions of the recent AIEE national technical meeting, New York, N. Y., sponsored by the AIEE committee on protective devices.

Because of the increasing importance of pilot-wire relaying in the industry, the relay subcommittee, at the session on relays held January 25, presented a report on the reliability of pilot-wire relaying circuits, including both privately owned and leased wires. Experience reported indicates very satisfactory results from this source.

Two other relaying papers, one on a new-type differential relay, and one on the effect of current-transformer residual magnetism on differential relays, indicate the increasing complexity of the mathematical theory involved in the higher-speed differential relays.

In the discussion it was pointed out that very few pilot-wire troubles occur on pilot wire of number 16 size and larger, and that pilot-wire relaying is superior to carrier in cost and performance on short lines.

The working group on fault-current-limiting devices reported on the correlation of system overvoltages and system grounding impedances. This report is a result of a number of years' theoretical analysis on the part of many of the working group members.

At the session on relaying long lines, January 26, a new development in circuit-breaker application was described by engineers of the General Electric Company in presentation of the paper dealing with switching overvoltages in high-voltage circuits. Analysis of the problem indicated the use of resistors which led to an extensive study of the problem in the laboratory using the transient analyzer. As a result the circuit breakers on 220-kv lines of the Southern California Edison Company were equipped with the internal resistors of the proper size, and both the staged tests and operating experience confirmed the effectiveness of the measure.

A group of three papers described a new protective-relaying scheme for use on unusually long transmission lines. Because the previously available relays would not function correctly under certain conditions arising on the very long lines, an analytical study of the problem was made, and the principle was suggested in the application of new relays. These relays, similar in appearance to the conventional induction cylinder type, but with proper windings and connections, were installed on the Kansas–Nebraska 270-mile 154-kv interconnection, and both the extensive study on the a-c network analyzer and a series of staged-fault tests proved that they performed satisfactorily. The installation of these new relays increased the reliability of interconnection and permitted the heavier loading.

The emphasis of the session on circuit breakers and switches, January 28, was on air-blast circuit breakers, three papers being presented on this topic. The papers stressed particularly the small amount of critical material inherent in this type of device. Attention was also directed to the suitability of air-blast breakers to fast reclosing because of their low inertia.

Operators suggested that mechanical features of these breakers could be improved to render their mechanical performance equivalent to the electrical performance, which they have found to be satisfactory. Recognition of the inability of air-blast breakers of present design to accommodate

bushing current transformers as a defect to be corrected was taken by both designers and operators.

One paper described an improved interrupter for oil circuit breakers in the high-voltage field which affords a saving of critical materials with improved performance.

An isolating switch employing a self-generated air blast capable of interrupting exciting currents was the subject of a paper which aroused discussion as to proper ratings for this type of switch.

T. G. LeClair, chairman of the protective devices committee, presided at the sessions on relaying, and circuit breakers and switches; Mr. LeClair and Philip Sporn, chairman of the committee on power transmission and distribution presided together at the session on relaying long lines. (*T. G. LeClair, chairman, AIEE protective devices committee.*)

Radio Chief Subject at Instruments and Measurements Session

Recent developments in radio measurements was the major subject of discussion at the session sponsored by the committee on instruments and measurements during the recent AIEE national technical meeting in New York, N. Y. T. S. Gray, vice-chairman of the committee, presided. Approximately 70 attended.

The first paper, "An Electromechanical Calculator for Directional-Antenna Patterns," by C. E. Smith (M '38), United Broadcasting Company, Cleveland, Ohio, and E. L. Gove (M '35), North Hollywood, Calif. (AIEE *Transactions*, 1943, February section, pages 78–83) described an electromechanical directional-antenna pattern calculator designed for the rapid solution of directional-antenna patterns. One of these calculators, which has been put into operation at the transmitting plant of radio stations WHK–WCLE, automatically will draw the horizontal pattern of a four-element system as well as the field-intensity contours at various elevation angles. The calculator operates by starting with a simple mechanical system of vectors on a motor-driven turntable, converting to an electric system for flexibility, and finally converting back to a mechanical system for drawing the resultant curve of antenna pattern.

A paper by C. M. Foust (M '31) and C. W. Frick (A '19), both of General Electric Company, Schenectady, N. Y., entitled "Measurements Pertaining to the Co-ordination of Radio Reception With Power Apparatus and Systems," presented the results of practical experience with standard equipments and methods for the measurement of radio-influence factors, the sources of which are power apparatus and systems. The various elements in the chain between the generating sources of influence such as motors and transformers, power lines and insulators, and the noise measured in the radio set were described and analyzed. The effect on noise of increasing the number of insulators in parallel was developed. Also tables giving measured values of radio-influence voltage (*RIV*) and limits of *RIV* for the different generating sources of radio influence were given.

Tests and methods for calculating the over-all effects on radio reception resulting from radio-frequency voltages produced by power apparatus was the subject of a paper, "Effect of Radio Frequencies of a Power System on Radio-Receiving Systems," by C. V. Aggers (A '39), Westinghouse X-Ray Company, Inc., Long Island City, N. Y., W. E. Pakala (A '38), Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., and W. A. Stickel, West Penn Power Company, Pittsburgh, Pa. Field tests were made to determine the coupling factor of antennas in a city receiving power from 25-kv transmission lines and 4-kv distribution circuits. A radio-frequency generator was connected to the 25-kv bus at the substation, and field-intensity measurements were made near the power lines and at 29 receiver antennas located at various distances. Such useful data as equivalent height of outdoor antenna, types of grounds, and distances from antenna to the power line were obtained.

An electronic instrument which measures the arcing time of a contact when closing or opening a circuit was described in another paper presented at the session by Walther Richter (F '42), consulting engineer, and W. H. Elliott (A '40), Cutler-Hammer, Inc., both of Milwaukee, Wis., entitled "An Instrument for the Determination of Contact Making and Breaking Time" (AIEE *Transactions*, 1943, January section, pages 14–16). An electronic-tube circuit is so arranged that a constant current flows into a capacitor only during the time that an arc exists across the contacts under test. Two tubes are so connected that one produces a blocking action on the circuit to the capacitor when the current to the contact is zero, and the other produces a blocking action when the drop across the contacts is practically zero. Hence current can flow to the capacitor only when current is flowing to the contacts and an arc drop simultaneously exists across the contacts. The charge accumulated in the capacitor, which is a measure of the time, is determined by a vacuum-tube voltmeter which measures the voltage across the capacitor.

A method of testing the insulation of windings by the application of recurring traveling waves by means of a repeating type of surge generator was explained in a paper presented by C. M. Foust (M '31) and N. Rohats (A '36), both of General Electric Company, Schenectady, N. Y. The dielectric stresses between different turns or between phase terminals are determined by a cathode-ray oscillograph, which is timed to the repeating surges so as to give a stationary wave on the screen. Oscillograms of waves obtained at different parts of windings and with different connections of the windings are given in the paper. (*C. L. Dawes, secretary, AIEE committee on instruments and measurements.*)

Conference on Electronic Tubes Covers Wartime Practices

Methods of operating electronic devices in order to increase their life and usefulness were discussed at the conference on getting the most out of electronic tubes in wartime held during the recent AIEE national technical meeting under sponsorship of the committee on electronics. Some 100 persons attended. Scheduled speakers were C. C. Herskind (M '40) and D. W. Jenks, both of the General Electric Company, Schenectady, N. Y.; E. E. Spitzer, RCA Manufacturing Company; and G. H. Rockwood, Jr. (M '34), Bell Telephone Laboratories, New York, N. Y.

The speakers discussed the various classes of electronic devices in wide use and the methods of rating them. In general, the users of electronic tubes were advised to follow carefully the instructions of the tube manufacturer and not exceed the rating, except when the manufacturer has been consulted specifically. In many cases under present conditions, manufacturers are

Snapped at the AIEE winter national technical meeting were (left to right) Bartow Van Ness, Jr., Safe Harbor Water Power Corporation, Baltimore, Md.; Marvin W. Smith, Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.; and T. G. LeClair, Commonwealth Edison Company, Chicago, Ill.

more readily able to supply advice than replacements. Many detailed recommendations concerning the operation of tubes were made.

In the broadcast field it was noted that the Federal Communications Commission had ordered station operators to reduce their radiated power by 20 per cent in order to permit a substantial reduction in the operating demands on the output amplifier tubes. The FCC has issued a booklet giving operating methods designed to lengthen the life of vacuum tubes in service.

In the mercury-arc rectifier field, practically all equipment is of the latest design, since it has been installed as a result of the great expansion required by the war-production program. In general, such modern equipment has been rated up to the limits of its capabilities. Electronic rectifiers have permitted a great saving of critical materials. In a typical electrochemical installation the steel and copper requirements of the mercury-arc rectifier equipment are 33 per cent less than those of the equivalent rotating machinery.

In the informal discussion period which terminated the conference, tube manufacturers, equipment manufacturers, circuit designers, industrial users of electronic equipment, and students participated. (*S. B. Ingram, chairman, AIEE committee on electronics.*)

Varistor Characteristics Discussed at Winter Technical Meeting

The class of solid nonohmic conductors known as "varistors," which has been put to use recently in the fields of communication and electrical engineering, was the subject of informal discussion at a conference held January 29 during the AIEE national technical meeting. W. C. White, member of the AIEE communication and electronics committees, presided.

The basic characteristics of varistors, the history of their recent development and their present uses, differentiation of the various types, and conjecture as to their possible applications in the future furnished the subject matter of the conference.

The general subject was introduced by J. A. Becker, Bell Telephone Laboratories, New York, N. Y. Doctor Becker explained that the term "varistor" was applied to solid nonohmic conductors. The resistance of such conductors varies widely with current or voltage. Nonsymmetrical varistors include the so called dry or contact rectifiers whereas symmetrical resistors showed no appreciable properties of rectification. The term "thermistor," he explained, is a special class of symmetrical varistor in which the change of resistance with current or voltage varies rapidly with the change of temperature.

The specific characteristics and advantages and disadvantages of the several types of "varistors" were presented by the following speakers: the nonsymmetrical types: copper-oxide rectifiers, L. O. Grondahl (M '42), Union Switch and Signal Company, Swissvale, Pa.; selenium rectifiers, C. A. Kotterman, Federal Telephone and Radio Corporation; copper-sulphide rectifiers, F. D. Williams, Jr., Samuel Ruben Electro and Physical Laboratories; symmetrical types: Thyrite, D. D. MacCarthy (A '28), General Electric Company, Pittsfield, Mass., and "thermistors," G. L. Pearson, Bell Telephone Laboratories, Inc., New York, N. Y.
(*R. E. Smith, chairman, subcommittee of AIEE committee on communication.*)

Session on Basic Sciences

Five papers on diversified subjects were presented at the session on basic sciences held January 26 during the AIEE national technical meeting in New York, N. Y. The liveliness of the discussion indicated a healthy difference of opinion and the need for continuing investigation in all the subjects considered.

One of the functions of the basic sciences committee is to bring to the attention of members of the engineering profession new concepts and information being acquired by workers in the basic sciences, like mathematics, physics, chemistry, and metallurgy. Three of the papers presented at this session gave the results of mathematical analysis. Two of these reported new information regarding inductance and resistance of conductor shapes of commercial importance, while the third showed another step in the application of tensor analysis to electromechanical systems.

The two experimental papers presented new results in the sequence of observations as old as man, namely the generation of electricity by friction. Millions of dollars have been spent in the still unfinished attempt to understand the cause and predict the behavior of lightning. One paper added to the long list of publications in this field. The other experimental paper reported laboratory investigations set up to explain the much smaller-scale but nonetheless disconcerting and not uncommon experience of shocks resulting from the accumulation of static charges on rubber-tired vehicles. (*H. H. Race, chairman, and R. W. Ager, vice-chairman, AIEE committee on basic sciences.*)

PERSONAL • • • •

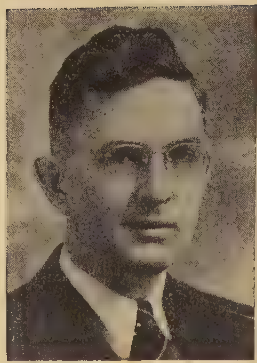
Joseph Slepian

Joseph Slepian (A '17, F '27) associate director of research, research laboratories, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., has been awarded the Lamme Medal for 1942, "for his contributions to the development of circuit-interrupting and current-rectifying apparatus." Born on February 11, 1891, in Boston, Mass., Doctor Slepian received the degrees of bachelor of arts in 1911, master of arts in 1912, and doctor of philosophy in 1913, from Harvard University. He spent a year studying mathematical physics at the University of Gottingen, Germany, and at the Sorbonne, Paris, France, before becoming instructor of physics at Cornell University, Ithaca, N. Y., for one year. After a period in the apprenticeship course at the Westinghouse Electric and Manufacturing Company, he entered that company's research department in January 1917. In less than a year he was appointed to the consulting position which he still fills. In 1922 he was named engineer in charge of the general section of the laboratories, in 1926 research consulting engineer, and in 1938 associate director. He has been active in the development of autovalve lightning arresters, the ignitron, mercury arc rectifiers, De-ion circuit breakers, and high voltage fuses. He has contributed many papers to mathematical and physical reviews as well as to AIEE *Transactions*. He was awarded the John Scott Medal in 1932 and was co-author of the paper which received the AIEE national prize for the best paper in theory and research for 1933. He is a member of the American Association for the Advancement of Science, the National Academy of Sciences, the American Physics Society, American Electrochemical Society, American Mathematical Society, and Phi Beta Kappa. He has served on the AIEE committees on basic sciences of which he was chairman for 1933–34, electric welding, technical program, research, and electronics. He holds a number of patents.

N. E. Funk Nominated for AIEE President

Nevin Elwell Funk (A'07, M'13, F'34) vice-president in charge of engineering, Philadelphia (Pa.) Electric Company, has been nominated to serve as president of the AIEE for the 1943–44 term. Mr. Funk was born on November 4, 1883, in Bloomsburg, Pa., and graduated from Lehigh University in 1905 with the degree of electrical engineer. During 1905 and part of 1906 he was entered in the apprentice shop course of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. In 1906 he worked as sub-foreman with the New York Central Railroad Company, Berwick, Pa., before joining the faculty of the Georgia School of Technology, Atlanta, Ga., as assistant professor of electrical and experimental engineering for one year.

N. E. Funk



L. A. Bingham

W. E. Wickenden

C. W. Ricker

As assistant foreman and then as assistant superintendent of operation he worked for the Philadelphia Electric Company from 1907 to 1912. He was sales manager of the Sterling Switchboard Company, Camden, N. J., from 1912 to 1914, when he returned to the Philadelphia Electric Company as secretary of the overhead line construction committee. In rapid succession he became combustion engineer in 1914, assistant to the operating engineer in 1915, superintendent of the Schuylkill generating station and assistant operating engineer in 1917. He was operating engineer from 1918 to 1926 when he became assistant chief engineer. He was appointed chief engineer and assistant general manager in 1928 and vice-president in charge of engineering in 1929. In addition he holds executive positions in several utility companies operating in the Philadelphia area. He received the Bronze Medal of the International Jury of Awards in 1926. He has served on the AIEE committees on synchronous converter tests for 1924–25, standardization for 1924–25, power generation from 1924 to 1935, legislation affecting the engineering profession from 1934 to 1941, transportation from 1934 to 1937, finance from 1935 to 1938, code of principles of professional conduct for 1935–36, and is now a member of the committee on posthumous awards. He held the chairmanship of the Lamme Medal Committee from 1936 to 1938, of the Edison Medal Committee from 1941 to 1943, and of the 1941 winter convention committee. From 1934 to 1938 he was a national director. He is also a member of the American Society of Mechanical Engineers and the Franklin Institute.

Wickenden, Ricker, Bingham, Gilson, and Gaylord are Nominated for Vice-Presidents

William Elgin Wickenden (A '07, M '13, F '39) president of the Case School of Applied Science, Cleveland, Ohio, has been nominated AIEE vice-president for the Middle Eastern District (2). He was born on December 24, 1882, at Toledo, Ohio, and graduated from Denison University with the degree of bachelor of science in 1904. In addition he has been awarded the honorary degrees of doctor of engineering by Lafayette College in 1926, Worcester Polytechnic Institute in 1927, the Case School of Applied Science in 1929, the Rose Polytechnic Institute in 1932. He also received the degree of doctor of science from Denison University in 1928, and Bucknell University in 1930, that of doctor of laws from Oberlin College in 1930, and that of doctor of humane letters from Otterbein College in 1933. In 1935 he was awarded the Lamme medal. His professional career began with an appointment as instructor in applied electricity at Mechanics Institute, Rochester, N. Y. In 1905 he joined the faculty of the University of Wisconsin, Madison, as assistant in physics becoming instructor in electrical engineering the following year. He was named assistant professor of electrical engineering at Massachusetts Institute of Technology, Cambridge, in 1909, and remained in that position until 1918. From 1918 to 1922 he was with the Western Electric Company and the American Telephone and Telegraph Company, first as personnel director and then as assistant vice-president. In 1922 he accepted the position of director of investigation for the Society for the Promotion of Engineering Education. In 1929 he was elected president of the Case school. His AIEE activities include Cleveland Section chairmanship for 1936–37, general chairman of the 1943 summer technical convention, and service on the committees on education for 1918–19, and for 1922–23, the Edison medal for 1942–43, technical program for 1922–24 and for 1937–38, and student branches for 1928–29. He has been active in civic as well as professional affairs, serving as chairman of the Ohio Labor Board, the Ohio Highway Survey Committee, director of the Cleveland Community Fund, and vice-president of the Cleveland Welfare Federation. In 1933–34 he was president of the SPEE, in 1933 president of the Ohio College Association, and in 1936–37 vice-president of the American Association for the Advancement of Science. In addition he is a fellow of the American Society of Mechanical Engineers, and a member of the American Association of Political and Social Science.

Claire William Ricker (A '18, M '36) professor and head of school of electrical engineering, Tulane University, New Orleans, La., has been nominated AIEE vice-president for the Southern District (4). Born on January 11, 1891 at Rantoul, Ill., he received a bachelor of science degree in 1914 and a master of science degree in electrical engineering in 1915 from the Massachusetts Institute of Technology. After working in the transmission department of the Western Electric Company, New York, N. Y., for one year, he was appointed, in 1916, instructor in the electrical engineering laboratory at the Massachusetts Institute of Technology, Cambridge. In 1918 he was placed in charge of the laboratory and in 1920 became assistant professor of electrical engineering. From 1926 to 1928 he was professor of electrical engineering at North Carolina State College, Raleigh. In 1928 he joined the faculty of Tulane University as professor of electrical engineering in charge of his department. In 1937 he was named head of the school of engineering. He is co-author of an electrical engineering textbook and a member of the Society for the Promotion of Engineering Education. He served on the AIEE committee on student branches from 1938 to 1941. He was New Orleans section chairman in 1936–37 and student branch counsellor from 1936 to 1939. At present he is a member of the committee on education.

Lloyd Arthur Bingham (A '29, M '39) assistant professor in electrical engineering at the University of Nebraska, Lincoln, has been nominated AIEE vice-president for the North Central District (6). He was born in Central Falls, R. I., on May 16, 1903. He received the degree of bachelor of electrical engineering from Northwestern University in 1924 and from Massachusetts Institute of Technology the degrees of bachelor of science in engineering in 1927 and master of science in 1928. He began his teaching career as instructor of electrical engineering at Northeastern University, Boston, Mass., serving from 1924 to 1926. For the next three years he was at the Massachusetts Institute of Technology first as teaching assistant and then as instructor of electrical engineering. In 1929 he was appointed instructor in electrical engineering at the University of Nebraska, and in 1930 became assistant professor. He is co-author of a textbook on power and telephone transmission lines. He has

served on the AIEE membership committee for 1933–35 and for 1941–42, was Nebraska section chairman for 1940–41, and student branch counsellor from 1935 to 1942. He is also a member of the Society for the Promotion of Engineering Education.

Walter Jay Gilson (A '26, M '38) general manager, Eastern Power Devices, Ltd., Toronto, Ont., has been nominated AIEE vice-president for the Canada District (10). He was born on March 17, 1889, in Napa County, Calif., and graduated from the electrical science course at Victoria University, Manchester, England, in 1916. After three years service in the British army, he joined the Canadian General Electric Company doing test, drafting, and installation work until 1921. From 1921 to 1925 he worked at drafting and construction for the North Davidson Gold Mine, Ont., the Pacific Gas and Electric Company, Pit River Development, Calif., the Metropolitan-Vickers Company, Manchester, Eng., the Electrical Control Limited, Glasgow, Scotland, and the Canadian and General Finance Company. He was assistant superintendent of construction for the Mexican Light and Power Company, Mexico City, from 1925 to 1927. Joining the Eastern Power Devices, Ltd. as electrical engineer in 1927, he was placed in charge of design and general management in 1931. He was elected Toronto section chairman in 1938–39 and served on the AIEE membership committee for 1941–42.

James Mason Gaylord (A '07, M '13, F '35) chief electrical engineer, Metropolitan Water District of Southern California, Los Angeles, has been nominated AIEE vice-president for the Pacific District (8). He was born on May 15, 1880, in Ashford, Conn., and received the bachelor of science degree in electrical engineering from Throop Polytechnic Institute in 1902 and from Massachusetts Institute of Technology in 1907. From 1902 to 1905 he was employed by the Edison Electric Company, Los Angeles, Calif., first as station operator and then as electrical foreman. In 1907 he was appointed electrical assistant by the United States Reclamation Service and remained in that position until 1923, when he became assistant engineer and finally chief engineer. He was employed by the Southern California Edison Company from 1923 to 1931 as transmission engineer, hydro-engineer from 1924 to 1928, and superintendent of hydro-generation from 1928 to 1931. In 1930 he became chief electrical engineer for the Metropolitan Water District of Southern California. He is co-author of a book on high pressure reservoir outlets. He has held the local AIEE offices of Los Angeles section secretary for 1938–39 and chairman for 1940–41.

W. I. Slichter Renominated for AIEE Treasurer

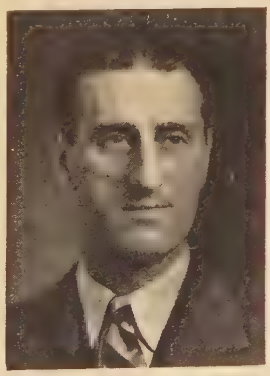
Walter Irvine Slichter (A'00, M '03, F '12) professor emeritus of electrical engineering, Columbia University, New York, N. Y., has been renominated for the position of AIEE treasurer. He has held that office since 1930. He was born May 7, 1873, and graduated from Columbia University in 1896 with the degree of electrical engineer. After one year in the testing department of the General Electric Company, Schenectady, N. Y., he was transferred as an assistant to the office of Dr. C. P. Steinmetz where he worked on a-c machinery design for five years. From 1903 to 1909 he worked on the equipment of electric railways for the General Electric Company. In 1910 he was named professor of electrical engineering and head of that department at Columbia University. During the first world war he was civilian director of the air service school for radio officers at Columbia. At present he is AIEE representative on the Engineering Societies Monographs Committee and on the Engineering Foundation Board. He is also serving on the committees on constitution and bylaws, the Edison Medal, and the standards committee.

Mortensen, Mier, and Laffoon Nominated for Directorships

Soren H. Mortensen (A '09, M '12, F '20) chief electrical engineer, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., has been nominated to serve on the AIEE board of directors. Born on November 4, 1878, in Eskelund, Denmark, he received the degree of bachelor of arts from Ribe Latin School in Denmark in 1916 and the degree of electrical engineer and mechanical engineer from the Polytechnicum of Mittweida, Germany, in 1902. He was employed by the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa., as a draftsman in 1903, later entering the mechanical engineering department. From 1905 to 1908 he was draftsman and designer of d-c motors and turbogenerators for the Bullock Electric Company, Cincinnati, Ohio. When that company was taken over by the Allis-Chalmers Company in 1908 he became designing electrical engineer of d-c motors and generators at Milwaukee. Until 1932 he continued as designer of turbogenerators and rotating synchronous machines. In that year he was placed in charge of a-c design. In 1942 he was named chief electrical engineer. He has served on the AIEE committees on membership from 1925 to 1930, on electrical machinery from 1932 to 1943, on application to iron and steel products for 1934–35, on standards from 1935 to 1943, on publication for 1940–41, and on technical program for 1942–43. He is the author of textbooks and articles on the theory and design of synchronous machines.

Conrad Walker Mier (A '25, M '31, F '39) engineer, Southwestern Bell Telephone Company, Dallas, Tex., has been nominated to serve as an AIEE director. He was born on September 21, 1886, at St. Louis, Mo., and graduated with the degree of bachelor of science in electrical engineering from Washington University in 1909. Since 1910 he has been connected with the Bell Telephone Company in various positions. He acted as special agent for the Southwestern Bell Telephone Company from 1910 to 1912, making surveys on the extension of long-distance telephone lines into new areas. In 1912 and 1913 he was employed as traffic engineer in St. Louis, Mo. He was transmission engineer from 1916 to 1926, when he was made transmission and protection engineer. After holding that position for one year, he was appointed area engineer for the state of Oklahoma. In 1936 he was transferred to the state of Texas as area engineer. He has previously held local AIEE offices serving

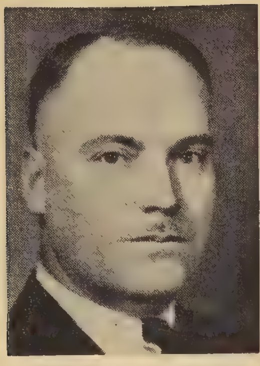
T. M. Gaylord



W. J. Gilson

C. W. Mier

S. H. Mortensen



C. M. Laffoon

as Seventh District secretary from 1934 to 1936, Oklahoma City Section chairman for 1929–30, Dallas Section secretary for 1938–39, and from 1939 to 1942 as chairman of the North Texas Section.

Carthrae Merrette Laffoon (A '24, M '39) engineering manager of the a-c generator engineering department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., has been renominated to serve on the AIEE board of directors. Mr. Laffoon was elected to the board of directors in June 1942 to fill the unexpired term of R. E. Hellmund (F '13). At present Mr. Laffoon is also a member of the AIEE committees on electrical machinery and the Lamme medal. A fuller biography of Mr. Laffoon was published in the July 1942 issue of *Electrical Engineering*, pages 362–3.

David Hall (A '03, F '18) assistant to Pacific coast manager, engineering and service department, Westinghouse Electric and Manufacturing Company, Los Angeles, Calif., has retired. Born at Fayetteville, Tenn., on July 30, 1874, he received the degree of electrical engineer from Lehigh University in 1896. He was employed by the Bullock Electric and Manufacturing Company, Cincinnati, Ohio, from 1896 to 1901 as purchasing agent, curve engineer, and designing engineer. In 1901 he became chief engineer for the Milwaukee (Wis.) Electric Manufacturing Company. Returning to the Bullock company in 1903 as assistant chief electrical engineer, he worked at d-c designing until 1908 when he become chief electrical engineer with the Allis-Chalmers Company, Milwaukee, Wis. As designer of d-c equipment he joined the Westinghouse Electric and Manufacturing Company in East Pittsburgh, Pa., in 1908. From 1911 to 1926 he was given charge of the design and construction of heavy d-c machinery as section engineer in the power division. In 1926 he was transferred to the Los Angeles area as head of engineering activities. He was named assistant to the Pacific Coast District engineering and service manager in 1941. Since 1933 he has been special lecturer on electrical machine design at the University of Southern California. He is a member of Tau Beta Pi and Eta Kappa Nu.

J. E. Warren (M '28) president of the Southern Bell Telephone and Telegraph Company, Atlanta, Ga., has been elected chairman of the company's board of directors. He was born December 3, 1878, in Beech Grove, Tenn., and studied at the University of Nashville. He joined the Telephone company in 1900 and was employed in various clerical positions until 1907, when he was made general purchasing agent. In 1912 he became superintendent of supplies and was made plant superintendent in 1918. From 1919 to 1925 he was assistant to the president. He became general plant manager in 1925, general manager in 1928, vice-president in 1930, and president in 1935. **H. S. Dumas** (A '40) vice-president, has been elected president of the company. Born September 19, 1892, at Macon, Ga., he graduated from the Alabama Polytechnic Institute with the degree of bachelor of science in 1911. Since 1911 he has been with the Telephone company holding various positions in the traffic department until 1926 when he was made Alabama traffic superintendent. From 1929 to 1934 he was general traffic supervisor, becoming assistant vice-president and assistant to the president in 1934 and 1935, respectively. In 1936 he was made general plant manager and operating vice-president in 1938.

E. C. Molina (M '22) switching theory engineer of the systems development department, Bell Telephone laboratories, New York, N. Y., has retired. Mr. Molina was born December 13, 1877, in New York, N. Y. In 1898 he was employed by the Western Electric Company, New York, N. Y., as an engineering assistant, and three years later moved to the engineering department of the American Telephone and Telegraph Company, Boston, Mass., where he experimented on the applications of physics to telephony. In 1905 he joined the circuit design department. He was placed in charge of the applications of the mathematical theory of probabilities to trunking problems in the newly formed development and research department in 1919. He continued this line of research as switching theory engineer in the Bell Telephone laboratories since 1925. He holds numerous patents. He is a fellow of the Royal Economic Society, Institute of Mathematical Statistics, and the American Association for the Advancement of Science, and a member of the American Mathematical Society, the Mathematical Association of America, the American Astronomical Society, the American Statistics Association, and the Econometric Society.

G. R. Milne (A '21, M '30) outside plant engineer, Consolidated Edison Company of New York (N. Y.), Inc., has been appointed assistant purchasing agent. He graduated from Stevens Institute with the degree of mechanical engineer in 1919 and became an engineering assistant with the United Electric Light and Power Company, New York, N. Y., in 1920. **A. R. Collard** (A '36) assistant general superintendent, electric distribution construction, has been made assistant engineer in the Astoria plant bureau. He graduated from the University of Iowa with the degree of bachelor of science in electrical engineering in 1919, and the following year joined the New York (N. Y.) Edison Company as an instrument inspector. **W. B. Fisk, Jr.** (A '28, M '34) division engineer, electrical engineering department, has been appointed assistant general superintendent. He received the degree of bachelor of science in electrical engineering from Alabama Polytechnic Institute in 1927, joining the Brooklyn (N. Y.) Edison Company the same year. **H. C. Otten** (A '23, M '29) assistant manager of the systems operations department has been made division engineer of the electrical engineering department. Mr. Otten graduated from the Stevens Institute of Technology in 1920 and became an engineering assistant with the United Electric Light and Power Company, New York, N. Y.

H. W. Hitchcock (A '15, F '37) chief engineer, Southern California Telephone Company, Los Angeles, Calif., has been appointed vice-president in charge of regulatory matters. He was born on January 1, 1890, at Lincoln, Neb., and graduated from Pomona College with the degree of bachelor of science in 1911. In 1913 he joined the engineering department of American Telephone and Telegraph Company, New York, N. Y., doing transmission work. He was transferred to the department of development and research in 1919. From 1921 to 1924 he worked at transmission and protection in the Pacific Telephone and Telegraph Company, San Francisco, Calif. In 1924 he was placed in charge of all transmission and protection work for the Southern California Telephone company and in 1928 became chief engineer.

F. J. Reynolds (A '20) engineer with the Hartford (Conn.) Electric Light Company, has retired from active duty. He will continue to serve that company in an advisory capacity. Mr. Reynolds was born on May 24, 1867, at Clermont, N. H., and graduated from Dartmouth College in 1889. From 1890 to 1898 he was assistant district engineer in the Cincinnati, Ohio, office of the General Electric Company. He was transferred to Schenectady, N. Y., in 1898 and given charge of large turbogenerators, rotary stations, and substations until 1907. He had charge of the installation of large apparatus in the New York district from 1907 to 1917. In 1917 he joined the Hartford company as chief engineer in charge of all design and construction.

C. F. Hanson (M '37) technical director of the Irvington (N. J.) Varnish and Insulator Company, has been appointed chief consulting engineer responsible for expediting technical work on war production. He received the bachelor of science and master of science degrees from the University of Kansas in 1912 and 1913. As assistant

physicist and acting chief of section he was with the National Bureau of Standards from 1913 to 1918. He engaged in research for the Habirshaw Cable and Wire Corporation, Yonkers, N. Y., from 1918 to 1927, and for R. T. Vanderbilt Company, New York, N. Y., from 1927 to 1930. Since 1930 he has been with the Irvington Varnish company.

H. C. Carpenter (A '01, F '22) vice-president of the New York (N. Y.) Telephone Company has retired. Born July 3, 1878, in New York, N. Y., he graduated from Columbia University in 1899. He entered the employ of the New York Telephone company as assistant to the engineer in charge of plant additions the same year. In 1907 he was placed in charge of the department preparing plans for all plant additions. From 1912 to 1919 he worked as an engineer. He was made chief engineer in 1919 and general manager three years later. In 1926 he was appointed vice-president in charge of staff functions of the company.

P. B. Juhnke (M '20, F '36) assistant chief operating engineer with Commonwealth Edison Company, Chicago, Ill., has been made chief operating engineer. Joining the company in 1903 he held the positions of construction helper, foreman, and oil switch maintenance man, in 1903 and 1904. In 1905 he became load dispatcher and chief load dispatcher in 1913. He was appointed a member of the Commonwealth Edison Advisory Committee in 1929 and assistant chief operator in 1942. He was a member of the AIEE board of directors for 1933–34, and chairman of the Chicago Section in 1928.

F. D. Crawford (A '30, M '36) superintendent, distribution operation department of the Brooklyn (N. Y.) Edison Company, has been made superintendent of the East River plant of the Consolidated Edison Company of New York (N. Y.), Inc. He joined the Brooklyn Edison company in 1921 as a cable splicer becoming foreman in 1923 and assistant supervisor in the cable bureau in 1927. In 1932 he was transferred to the service bureau of the distribution operation department as supervisor. Later he became assistant general superintendent and finally superintendent.

R. M. Kalb (M '42) assistant chief engineer of the Kellogg Switchboard and Supply Company, Chicago, Ill., has been appointed chief engineer. Mr. Kalb received the degree of bachelor of electrical engineering from Ohio State University in 1927 and spent a year at that university as a graduate assistant. From 1928 to 1941 he was employed by the Bell Telephone Laboratories, New York, N. Y., as research engineer working on transmission, circuits, and signalling systems. He joined the Kellogg company in 1941 as assistant chief engineer.

Uriah Davis (A '25, M '26) assistant chief load dispatcher for the Commonwealth Edison Company, Chicago, Ill., has been advanced to the position of chief load dispatcher. He joined the Edison company in 1904 as a substation operator, becoming a load dispatcher in 1906, and assistant chief load dispatcher in 1924.

R. E. Doherty (A '16, F '39) president of Carnegie Institute of Technology, Pittsburgh, Pa., was re-elected chairman of the Engineers' Council for Professional Development.

R. K. Lane (M '37) president of the Public Service Company of Oklahoma, Tulsa, has been elected president of the Tulsa Chamber of Commerce.

M. G. Crosby (M '41) research engineer, RCA Communications, Inc., has been elected vice-president of the New York section of the Institute of Radio Engineers.

R. H. Hillery (A '32) executive assistant, Hydro-Electric Power Commission of Ontario, Toronto, has joined the Royal Navy as an engineer lieutenant.

OBITUARY • • • •

Kaj Christian Christiansen (A '17, M '21) electrical engineer in the construction department of the Tennessee Valley Authority, died on December 5, 1942. He was born on April 12, 1891, at Copenhagen, Denmark. His career in the United States began with several positions as electrician in New York, N. Y., from 1907 to 1912. From 1912 to 1915 he was a draftsman for generating and substations in the engineering department of the New York (N. Y.) Edison Company. During 1915 he was with the Moulton Engineering Corporation, New Haven, Conn.; in 1916, with the Hydro-Electric Development, Ontario Power Company, Niagara Falls, Ont.; in 1917, with the Graphite Company, Niagara Falls, N. Y.; in 1918, with Stone and Webster, Philadelphia, Pa.; and in 1919, with the Electric Bond and Share Company, New York, N. Y. He joined the Phoenix Utility Company in 1919 as field electrical engineer, and a year later became superintendent in charge of all electrical construction, retaining that position until 1927. Returning to the Electric Bond and Share Company, in 1928, he handled design for that company's projects in the United States, Mexico, Columbia, and Argentina. From 1931 to 1935 he worked for the Safe Harbor Water Power Corporation, Conestoga, Pa., estimating costs and capital requirements. Appointed assistant in charge of electrical construction at Norris Dam by the Tennessee Valley Authority in 1935, he was transferred in 1936 to the Knoxville headquarters as associate engineer for scheduling procurement of all equipment for the Pickwick Landing Project in Tennessee. During 1939 he was electrical engineer and designer in North Carolina, for Murray and Flood, Consulting Engineers. In 1940 he returned to Safe Harbor Water Power Corporation and in 1941 was made head electrical engineer at the Watts Bar Dam, Tenn.

Nicholas Stahl (A '08, F '13) chief engineer of the Pennsylvania Light and Power Company, Allentown, died on January 1, 1943. Born in New Castle, Del., on July 2, 1876, he graduated in 1897 with a bachelor of arts degree from Princeton University. From that University he received a master of arts degree in 1898 and an electrical engineering degree in 1907. As a science master he taught at the Lawrenceville School, N. J., in 1898, and in 1900 he became head of the science department, a position which he held until 1906. In 1907 he entered the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., as an apprentice and remained with that company for twelve years. In succession he became corresponding engineer in the general contract division of the railway department, and head of that division in 1908, manager of the central station section of the railway and lighting department from 1909 to 1916, special representative of that department and assistant manager of the power department in 1917. From 1918 to 1927 he was superintendent of generation with the Narragansett Electric Lighting Company, Providence, R. I. The following year he served as vice-president of the United Public Service Company, Chicago, Ill. In 1928 he joined the Pennsylvania Power and Light Company as chief engineer.

Augustus Canfield Smith (M '15) sales engineering consultant, Buffalo Niagara Electric Corporation, Buffalo, N. Y., died on October 25, 1942. He was born in Brooklyn, N. Y., on May 6, 1873. Graduating from Pratt Institute in 1892, he entered the General Electric Company's student course at Schenectady, N. Y. From 1898 to 1902 he was employed as sales engineer for the General Electric Company's southern territory designing and installing power machinery. He was transferred in 1903 to that company's western New York territory to carry on the same work. He became sales engineer for the Cataract Power and Conduit Company Buffalo, N. Y., in 1907. In 1910 he joined the Tonawanda Power Company, North Tonawanda, N. Y., and in 1911 he joined the Canadian Niagara Power Company, Niagara Falls, Ont. When the Buffalo General Electric Company was formed by the merger of the two latter companies, he retained his position, continuing until 1927, when he was appointed general sales manager. In 1937 he was made consultant in the sales engineering group of the company which had become the Buffalo Niagara Electric Corporation. He was also a member of the Society of Illuminating Engineers.

Samuel Byrod Fortenbaugh (A '95, F '13) retired electrical engineer, General Electric Company, Schenectady, N. Y., died February 6, 1943. He was born July 31, 1869, at Halifax, Pa., and graduated from

Cornell University with the degree of mechanical engineer in 1890. He entered the experimental course of the Brush Electrical Company, Cleveland, Ohio. In 1890 he was appointed to take charge of commercial and experimental testing for the Short Electrical Railway Company, Cleveland, Ohio. He resigned in 1893 to return to Cornell University, from which he received the degree of master of mechanical engineering in 1894. He served as assistant professor of electrical engineering at the University of Wisconsin, Madison, from 1894 to 1898. After a year with the Walker Manufacturing Company, Cleveland, Ohio, he joined Dick, Kerr and Company, Preston, and London, England, as works engineer in 1899. From 1901 to 1906 he was employed as electrical engineer by the Underground Electric Railways Company of London, England. In 1906 he joined the heavy traction department of the General Electric Company, with which he remained until he retired in 1932.

William Herschel Fenley (A '14) western manager of the Kerite Insulated Wire and Cable Company, Chicago, Ill., died on November 22, 1942. Born on May 7, 1876, at Greenwood, Ind., Mr. Fenley began his career in 1900 as signal foreman on the Chicago Great Western Railroad. In succession he became inspector in 1904, supervisor in 1906, office engineer in 1906, and head of the signal department in 1908. In 1910 he became sales engineer for the Union Switch and Signal Company, Chicago, Ill. He joined the Panama Railroad in 1911 as signal engineer and spent the ensuing four years in the Canal Zone, where he worked on the construction of a trans-Isthmian duct line and underground conduit for the Panama fortifications. He was appointed superintendent of the telephone and signal department of the Panama railroad in 1913. He was employed by the Kerite company in 1915, and in 1922 became western manager. He was also a member of the Panama Canal Society, Western Society of Engineers, the American Railway Engineering Association, and the Society of Automotive Engineers.

Fred Pew McBerty (A '12) retired electrical engineer of Warren, Ohio, died on October 19, 1942. He was born on September 25, 1869, at Warren, Ohio. He was engaged as a builder of lamp machinery, dynamos, and motors for the Packard Electric Company, Warren, Ohio, from 1892 to 1894. From 1894 to 1897 he was employed by the Warren Electric and Speciality Company as master mechanic and chief electrician. After serving as chief electrician aboard the United States revenue cutter, Gresham, for a year, he became engineer and superintendent of the Peerless Electric Company, Warren, Ohio, in 1898. He resigned in 1906 to form the Peerless Transformer Company, which was reorganized in 1909 as the Enterprise Electric Company. In 1911 he became a partner in the National Electric Welder Company, Warren, acting as consulting engineer, secretary, and treasurer. When this company was reorganized in 1914 as the Federal Machine and Welder Company, he remained in the position of manager until 1924, when he became the owner. He retired in 1937.

William McCurdy Runyon (A '41) chief safety engineer, Anaconda Wire and Cable Company, New York, N. Y., died in June 1942. He was born July 31, 1894, at Stelton, N. J., and graduated from a course in applied electricity at Pratt Institute. He began his career as a cadet engineer in the Public Service Testing Laboratory, Newark, N. J., in 1916. From 1917 to 1919 he worked at various naval stations as a chief electrician in aviation. He was also a member of the Bureau of Steam Engineering, Washington, D. C., during this time. He was employed as head of the electrical department of the Perth Amboy (N. J.) Dry Dock Company, from 1919 to 1922. As sales engineer he worked from 1922 to 1937 for the Crouse Hinds Company, New York, N. Y. In 1937 he became consultant electrical sales engineer for the National Electrical Products Company, Pittsburgh, Pa. In 1939 he was appointed sales engineer by Russell and Stoll Company, New York, N. Y., remaining with them until 1941, when he entered the Anaconda company.

Edwin James Rutherford (M '35) engineer of equipment and buildings, long lines engineering department, American Telephone and Telegraph Company, New York, N. Y., died on December 10, 1942. He was born at Warkworth, Ont., on April 2, 1890. In 1913 he received the degree of bachelor of science from Dartmouth College. From 1913 to 1943 he was employed continuously in the long lines department of the American Telephone Company. He was first engaged in writing specifications for outside plant construction. In 1915 he worked on central offices equipment for transcontinental telephone circuits at Buffalo, N. Y. He was charged with installing equipment in various offices of the long lines plant and with handling general engineering practices for central office equipment from 1915 to 1925. In 1925 he was given supervision of the group doing equipment specification work. He was appointed equipment engineer in 1929 and engineer of equipment and buildings in 1934.

Robert Nelson Baylis (A '89, M '92) president of the Baylis Company and the Smokador Manufacturing Company, in Bloomfield, N. J., died September 5, 1942. He was born in Englewood, N. J., on March 16, 1867, and was graduated from Stevens Institute of Technology in 1887. After spending one year learning machine shop practice in the Southwark Foundry and Machine Company, Philadelphia, Pa., he joined the C. and C. Electric Motor Company, New York, N. Y., as draftsman in 1888. He was appointed electrician in 1889, shortly thereafter becoming chief electrical engineer. For several years he was chief electrical engineer with the Walker Manufacturing Company, Cleveland, Ohio. Prior to 1906 he was engaged as an expert in patent litigation. In 1906 he organized the Baylis Company and became its president. He was the inventor of the reaction type of brush holder for direct current generators and motors.

Maurice Moyssay Goldenstein (A '07, M '13) printing equipment electrical engineer died in October 1942. He was born July 24, 1879, at Kishinew, Russia, and graduated from the Technical University, Darmstadt, Germany, in 1906, with the degree of electrical engineer. He was employed in the engineering department of the Cutler-Hammer Manufacturing Company, Milwaukee, Wis., from 1906 to 1913. In that year he was transferred to the printing equipment department where he worked until 1921 on the design of large plant machinery. He joined the General Electric Company, Chicago, Ill., in 1922, remaining with that company until 1935 as district printing equipment specialist. Since 1935 he had been a consulting engineer. He was granted a number of patents by the United States and Canada.

John Coolidge Davenport (A '07, M '12) engineer in charge of all electrical equipment contracts at the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., died December 19, 1942. He was born February 23, 1881, at Boston, Mass., and received the degrees of bachelor of arts (1903), and master of arts (1904), from Harvard University. He immediately entered the electrical testing department of the Bullock Electric Manufacturing Company, Cincinnati, Ohio, and became junior transformer engineer in 1905. Since 1908 when the Bullock company was taken over by the Allis-Chalmers company he had worked chiefly at Milwaukee on the design of electrical machinery, especially large power transformers.

Milton Irvin Morgan (A '39) chief marine electrical engineer, Dravo Corporation, Pittsburgh, Pa., died on January 6, 1943. Born September 12, 1908, Mr. Morgan graduated from the University of Tennessee with the degree of electrical engineer in 1933. During 1933 and 1934 he was employed as efficiency engineer by the Memphis Power and Light Company. He was appointed assistant engineer in the design department of the Tennessee Valley Authority in 1935, working on the design of the Norris, Pickwick, and Watts Bar Plants. In 1940 he joined the Aluminum Company of America, Pittsburgh, Pa. This position entailed the design and construction of hydroelectric developments. In 1942 he joined the Dravo Corporation.

Per N. Sandstrom (A '25) supervising planning engineer, Commonwealth Edison Company, Chicago, Ill., died January 14, 1943. Born August 1, 1903, at Boden,

Sweden, he graduated from the electrical engineering college at Orebro in 1922. Coming to the United States in 1923 he joined the Western Electric Company, Chicago, Ill., as a draftsman. In 1924 he entered the employ of the Commonwealth Edison Company. He worked as draftsman from 1924 to 1926 when he became checking draftsman. In 1929 he was appointed supervising draftsman, and in 1930, assistant engineer in the office of the chief electrical engineer. From 1933 to 1937 he was planning engineer. He was made supervising planning engineer in 1937.

Howard Brewer Hosford (A '30) chief estimator in the electrical engineering department of the gas and water division of the Memphis (Tenn.) Power and Light Company, died in December 1942. He was born on September 24, 1885, and studied civil engineering at the University of Tennessee. In 1918 he worked as a civil and construction engineer for the Memphis (Tenn.) Gas and Electric Company, and during 1919–20 for the Memphis (Tenn.) Coal Mining Company. In 1920 when the above companies merged to become the Memphis Power and Light Company, he was appointed assistant engineer in the underground department. In 1922 he became chief estimator.

John R. O'Toole (A '39) engineer, electrical and wire rope department, American Steel and Wire Company, Atlanta, Ga., died on April 6, 1942. He was born on July 26, 1907, at Alliance, Ohio, and studied at Pomona College and Georgia School of Technology. He was employed by the American Steel and Wire Company in 1924 in the electrical wire and cable division, occupying several training positions until 1928, when he was made Atlanta representative of the division.

Charles Luther Summers (A '41) lieutenant in the Signal Corps of the United States Army died in action in Europe in 1942. He graduated from the University of California with the degree of bachelor of science in electrical engineering in 1940. In 1941 he was employed by the Westinghouse Electric and Manufacturing Company as an electrical tester. He remained with that company until he entered the United States Army.

MEMBERSHIP • •

Recommended for Transfer

The Board of Examiners, at its meeting on February 18, 1943, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the national secretary.

To Grade of Fellow

Flath, E. H., dean, school of engineering, Southern Methodist University, Dallas, Texas.
Hull, J. I., engineer in charge of Thomson Laboratory, General Electric Company, West Lynn, Mass.
Pearcy, N. C., electrical engineer, Public Utility Engineering & Service Corporation, Chicago, Ill.
Tenney, H. W., assistant director of research laboratories, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

4 to grade of Fellow

To Grade of Member

Boardman, R. L., meter engineer, Northwestern Electric Company, Portland, Oreg.
Burgett, L. S., assistant director of research and development, Clark Controller Company, Cleveland, Ohio.
Corson, A. J., instrument engineer, General Electric Company, West Lynn, Mass.
Cox, W. R., electrical engineer, General Electric Company, Lynn, Mass.
Farnsworth, G. C., electrical engineer, Public Service Company of Colorado, Denver, Colo.
Gahagan, J. E., assistant engineer, Consolidated Edison Company of N. Y., Inc., New York, N. Y.
Hastings, C. E., associate physicist, National Advisory Committee for Aeronautics, Langley Field, Va.
Hill, G. L., assistant engineer, Pacific Gas & Electric Company, Emeryville, Calif.
Jucciarone, N. T., engineer, Bureau of Ships, Washington, D. C.
Kistler, L. H., superintendent, meter and service departments, Northwestern Electric Company, Portland, Oreg.
Lewis, R. C., electrical designer, Basic Magnesium, Inc., Las Vegas, Nevada.
Leyland, S. C., section engineer, Westinghouse Electric & Manufacturing Company, Newark, N. J.
McAuley, P. H., laboratory engineer, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.
McCullough, R. T., engineer, Long Island Lighting Company, Mineola, N. Y.
Sargentich, D. M., electrical engineer, Basic Magnesium, Inc., Las Vegas, Nevada.
Savage, C. F., section head, aircraft instruments, General Electric Company, West Lynn, Mass.
Sonnemann, W. K., design engineer, Westinghouse Electric & Manufacturing Company, Newark, N. J.
Watkins, W. W., lieutenant, USNR, Bureau of Ordnance, Washington, D. C.
Wright, J. H., laboratory engineer, General Electric Company, West Lynn, Mass.

19 to grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Names of applicants in the United States and Canada are arranged by geographical District. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the national secretary before March 31, 1943, or May 31, 1943, if the applicant resides outside of the United States or Canada.

United States and Canada

1. North Eastern

Adler, B., Bethlehem Steel Company, Quincy, Mass.
Arnett, R. A., General Electric Company, Schenectady, N. Y.
Avey, C. W., Aluminum Company of America, Niagara Falls, N. Y.
Baker, N. A., Allis-Chalmers Manufacturing Company, Boston, Mass.
Barbour, P. K., General Electric Company, Lynn, Mass.
Bauersfeld, C. F., General Electric Company, Bridgeport, Conn.
Becker, H. C., Radiation Laboratory, Massachusetts Institute of Technology, Cambridge, Mass.
Becker, K. E., General Electric Company, Pittsfield, Mass.
Benish, J., General Electric Company, Syracuse, N. Y.
Blacet, J. E., 124 Pomeroy Ave., Pittsfield, Mass.
Brownell, J. W., General Electric Company, Lynn, Mass.
Bruce, P. M., General Electric Company, Schenectady, N. Y.
Burkhard, E., General Electric Company, Schenectady, N. Y.
Burt, C. E. (Member), The Trumbull Electric Manufacturing Company, Boston, Mass.
Carroll, J. C., General Electric Company, Schenectady, N. Y.
Clark, C. B., Radio Research Laboratory, Harvard University, Cambridge, Mass.
Clark, W. C., Bethlehem Steel Company, Lackawanna, N. Y.
Cline, S. T., General Electric Company, Schenectady, N. Y.
Cochran, N. B., General Electric Company, Schenectady, N. Y.
Degnan, W. J., General Electric Company, Schenectady, N. Y.
Dinkel, S. G., General Electric Company, Schenectady, N. Y.
Dixon, C., General Electric Company, Bridgeport, Conn.
Dolkart, L. (Member), Leonard Construction Company, Newport, R. I.
Doncyson, R. A., General Electric Company, Schenectady, N. Y.
Drake, D. T., Massachusetts Institute of Technology, Cambridge, Mass.
Duggan, J. R., Harvard University, Cambridge, Mass.
Easley, E. H., General Electric Company, Pittsfield, Mass.
Eckel, W. J., General Electric Company, Schenectady, N. Y.
Fearnot, C. D., General Electric Company, Schenectady, N. Y.
Ferderber, J., General Electric Company, Schenectady, N. Y.
Foster, A. E., Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y.
Frederick, A. H., Massachusetts Institute of Technology, Radiation Laboratory, Cambridge, Mass.
Gargett, R. E., General Electric Company, Schenectady, N. Y.
Guy, G. E., General Electric Company, Schenectady, N. Y.
Hamann, C. E., General Electric Company, Bridgeport, Conn.
Hoglund, R. H., Harvard University, Cambridge, Mass.
Horner, H. J., U.S.N.R., Boston Magnetic Ranges, Boston, Mass.
Hubbard, E. R., General Electric Company, Bridgeport, Conn.
Johnson, A. D., General Electric Company, West Lynn, Mass.
Johnson, J. C. (Member), Pratt and Whitney Aircraft, East Hartford, Conn.
Kalenik, E. J., General Electric Company, Schenectady, N. Y.
Kawecki, E., General Electric Company, Pittsfield, Mass.
Kelch, E. C., General Electric Company, Schenectady, N. Y.
Koch, H. J., Electrolux Corporation, Old Greenwich, Conn.
Lautenberger, E. W., General Electric Company, Schenectady, N. Y.
Leblanc, H. P., Boston Edison Company, Boston, Mass.
Lebowitz, R. A., General Electric Company, Bridgeport, Conn.
Lentz, J. J., Massachusetts Institute of Technology, Cambridge, Mass.
Lerstrup, K. (Member), Allis-Chalmers Manufacturing Company, Boston, Mass.
Ley, B. J., General Electric Company, Pittsfield, Mass.
Llewellyn, R. W., General Electric Company, Schenectady, N. Y.
Major, W. C., General Electric Company, Schenectady, N. Y.
McFall, R. W., General Electric Company, Bridgeport, Conn.
Mitchell, J. L., Allis-Chalmers Manufacturing Company, Boston, Mass.
Morrisson, N. J., Jr., Massachusetts Institute of Technology, Radiation Laboratory, Cambridge, Mass.
Munn, A. L., Jr., General Electric Company, Schenectady, N. Y.
Newman, R. C., General Electric Company, Pittsfield, Mass.
Ordung, P. F., Yale University, New Haven, Conn.
Parssinen, E. J., Box 19, Sandwich, Mass.
Peach, S. E., General Electric Company, Schenectady, N. Y.
Quill, J. S., General Electric Company, Schenectady, N. Y.
Ramakrishnan, P. R., General Electric Company, Schenectady, N. Y.
Schick, N. E., General Electric Company, Lynn, Mass.
Seifert, R. L., General Electric Company, Schenectady, N. Y.
Shambach, W. N., General Electric Company, Schenectady, N. Y.
Simon, C. J., General Electric Company, Schenectady, N. Y.
Simons, D., General Electric Company, Schenectady, N. Y.
Stack, S. S. (Associate re-election), General Electric Company, Schenectady, N. Y.
Teasdale, A. R., Jr., General Electric Company, Schenectady, N. Y.
Thiessen, W. F., General Electric Company, Schenectady, N. Y.
Tuerck, W., Jr., Van Norman Machine Tool Company, Springfield, Mass.
Warchol, E. J., General Electric Company, Schenectady, N. Y.
Warner, J. L., Tufts College, Mass.
Washburn, R. P., General Electric Company, Pittsfield, Mass.
Wessel, R. W., General Electric Company, Schenectady, N. Y.
Whitbread, R. L., Stone and Webster Engineering Corporation, Boston, Mass.
Whitney, L. E., General Electric Company, Bridgeport, Conn.
Wild, J. J., General Electric Company, Syracuse, N. Y.
Winn, O. H., General Electric Company, Schenectady, N. Y.
Wood, D. F., General Electric Company, Schenectady, N. Y.
Zuvers, H. E., General Electric Company, Schenectady, N. Y.

2. Middle Eastern

Aiello, A. F., United States Navy Yard, Philadelphia, Pa.
Ambrogi, J. N., Jr., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Amelotti, E., Villanova College, Villanova, Pa.
Annis, R. W., Naval Research Laboratory, Bellevue, D. C.
Bailey, E. S. (Member), Consolidated Gas Electric Light and Power Company, Baltimore, Md.
Beckman, V. C., National Advisory Committee for Aeronautics, Cleveland, Ohio.
Benson, J. H., Allis-Chalmers Manufacturing Company, Norwood, Ohio.
Bowdon, F. M., Philco Radio Corporation, Philadelphia, Pa.
Boyer, B. E., Naval Research Laboratory, Washington, D. C.
Breier, E. F., Navy Yard, Washington, D. C.
Breitenstein, F. H., United States Navy, % Supervisor of Shipbuilding, Pittsburgh, Pa.
Britton, J. A. (Member), Atlantic Refining Company, Philadelphia, Pa.
Broden, R. G., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Brodzinsky, A., Naval Research Laboratory, Anacostia Station, D. C.
Buflo, M. A., Westinghouse Electric and Manufacturing Company, Wilkinsburg, Pa.
Bulanchuk, W. J., United States Maritime Commission, Washington, D. C.
Burningham, C. A., War Department, Proving Ground, Aberdeen, Md.
Campbell, W. E., Westinghouse Electric and Manufacturing Company, Lima, Ohio.
Chedaker, J., Moore School, University of Pennsylvania, Philadelphia, Pa.
Clark, K. J., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Coville, H. A., General Electric Company, Erie, Pa.
Dallas, H. G., Jr., 703 Grantley St., Baltimore, Md.
Davidson, G. M., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Davis, D. W., United States Naval Academy, Annapolis, Md.
Davis, G. L., General Electric Company, Erie, Pa.
Del Balzo, P. L., Navy Department, Washington, D. C.
Derr, W. A. (Member), Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Devries, J. R. (Member), Baltimore Transit Company, Baltimore, Md.
Dill, E. C., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Donald, J. O., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Duncan, H. S., Sylvania Electric Products, Incorporated, Emporium, Pa.
Eales, H. S., Allis-Chalmers Manufacturing Company, Washington, D. C.
Eckels, A. R., Navy Department, Bureau of Ships, Washington, D. C.
Edutis, V. L., Naval Research Laboratory, Anacostia Station, Washington, D. C.
Elias, L. G., Naval Research Laboratory, Anacostia Station, Washington, D. C.
Erdman, H., Jr., War Department, Aircraft Radio Laboratory, Wright Field, Dayton, Ohio.
Ferrante, F. M., Aircraft Radio Laboratory, Wright Field, Dayton, Ohio.
Filliez, R. A., Navy Department, Bureau of Ships, Washington, D. C.
Fitzwilliam, M. S. (Member), U. S. Navy, Bureau of Yards and Docks, Washington, D. C.
Freed, I. F. (Associate re-election), Consolidated Gas Electric Light and Power Company, Baltimore, Md.
Galopin, F. E., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Gordon, D. I., Naval Ordnance Laboratory, Washington, D. C.
Grafinger, L. N., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Guthrie, H. G. 13916 Northfield Ave., East Cleveland, Ohio.
Halstead, G. G., General Electric Company, Erie, Pa.
Hamilton, E. L., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Hancock, J. W., Electric Tachometer Corporation, Philadelphia, Pa.
Heidbreder, J. F., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Hixson, R. N., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Hoffman, L. O., Briggs Clarifier Company, Washington, D. C.
Hoffmann, A. H., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Hope, E. M. (Associate re-election), United States Army Engineers, Cincinnati, Ohio.
Hopper, D. L., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
House, J. P., Jr., U. S. Army, Signal Corps, Washington, D. C.
Hurd, E. L., Jr., Naval Research Laboratory, Anacostia Station, Washington, D. C.
Knowles, D. J., Sylvania Electric Products, Incorporated, Emporium, Pa.
Krings, B. J., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Kuljian, H. A. (Member), H. A. Kuljian and Company, Philadelphia, Pa.
Landon, R. W., Bureau of Personnel, Navy Department, Washington, D. C.
Lebold, H. W., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Linsday, E. A., General Electric Company, Nela Park, Cleveland, Ohio.
Little, F. W., Electric Controller and Manufacturing Company, Cleveland, Ohio.
Lizzio, J. R., Philadelphia Signal Corps Inspection Zone, Philadelphia, Pa.
Loveberg, A. G., Jr., Naval Research Laboratory, Anacostia Station, Washington, D. C.
Magee, J. W. (Member), Westinghouse Electric and Manufacturing Company, Baltimore, Md.
Marcum, C. R., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Martin, H. C., Jr., Ambos-Jones Company, Cleveland, Ohio.
Maurer, J. M., General Electric Company, Philadelphia, Pa.
Miller, R. C., Sylvania Electric Products, Incorporated, Emporium, Pa.
Nimeroff, B., Navy Department, Bureau of Ships, Washington, D. C.
O'Brien, D. J., RCA Manufacturing Company, Camden, N. J.
O'Rear, H. O., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Palmes, A. H., Westinghouse Electric and Manufacturing Company, Baltimore, Md.
Patterson, H. G., Jr., Goodyear Tire and Rubber Company, Akron, Ohio.
Peake, H. J., Naval Research Laboratory, Anacostia Station, Washington, D. C.
Portofee, C. H., Chesapeake and Potomac Telephone Company, Washington, D. C.
Prasse, H. E. (Member), Atlantic Refining Company, Philadelphia, Pa.
Puchlowski, K. P., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Rawson, R. H., Jr., General Electric Company, Erie, Pa.
Ray, V. O., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Rhodes, L. T., RCA Manufacturing Company, Incorporated, Camden, N. J.
Rowe, J. M. (Member), E. I. du Pont de Nemours and Company, Wilmington, Del.
Schwartz, E. R., United States Maritime Commission, Philadelphia, Pa.
Sebold, G. K., General Electric Company, Philadelphia, Pa.
Secrist, P. W., Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Shafler, E. C., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Sherrard, R., Jr., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Simpson, J. W., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Smith, R. B., I-T-E Circuit Breaker Company, Philadelphia, Pa.
Snyder, F. O., B. F. Goodrich Company, Akron, Ohio.
Stankey, J. E., Naval Research Laboratory, Anacostia station, Washington, D. C.
Stiles, A. M., Westinghouse Research Laboratories, East Pittsburgh, Pa.
Stolaroff, M. J., United States Navy, Bureau of Ships, Washington, D. C.
Storry, J. O., Navy Department, Bureau of Ships, Washington, D. C.
Stringfellow, W. M., Radio Station WSPD, Toledo, Ohio.
Sunderland, J. R., Jr., The Atlantic Refining Company, Philadelphia, Pa.
Turner, W. R., Naval Ordnance Laboratory, Navy Yard, Washington, D. C.
Unruh, H. S., The Atlantic Refining Company, Philadelphia, Pa.
Wadhams, J. B. (Member), The Ohio Crankshaft Company, Cleveland, Ohio.
Wallace, O. T., P. & L. E. Railroad Company, Pittsburgh, Pa.
Washburn, F. L., Jr., Naval Research Laboratory, Anacostia Station, Washington, D. C.
Watton, A., Jr. (Member), United States Army Air Corps, Wright Field, Dayton, Ohio.
Weckerly, M. A., Toledo Scale Company, Toledo, Ohio.
Whisler, J. E., Jack & Heintz, Incorporated, Bedford, Ohio.
Williamson, J. W., 2958 Carlton Road, Shaker Heights, Ohio.
Witzig, W. F., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

3. New York City

Baumgartner, H. P., United States Signal Corps, Inspection Zone, Newark, N. J.
Borman, E., Bell Telephone Laboratories, Incorporated, New York, N. Y.
Boyce, R. S., Federal Telephone and Radio Corporation, Newark, N. J.
Brandler, A. B. (Member), College of the City of New York, New York, N. Y.
Bueffel, B. H., Jr., New York University, New York, N. Y.
Burkart, J. A., Western Electric Company, New York, N. Y.
Carples, E. N., United States Army, Signal Corps, New York, N. Y.
Connelly, J. F., Nilsson Electrical Laboratory, New York, N. Y.
Cortright, T. R., C-O Two Fire Equipment Company, Newark, N. J.
Coyle, F. J., 26 Eder Terrace, South Orange, N. J.
Denhard, W. G., Sperry Products, Incorporated, Hoboken, N. J.
Dobson, W. T., III, Sperry Gyroscope Company, Garden City, N. Y.
Dong, J. G., Fairchild Aviation Corporation, New York, N. Y.
Donoho, C. M., Jr., Westinghouse Electric Elevator Company, Jersey City, N. J.
Drazy, E. J., Bell Telephone Laboratories, Incorporated, New York, N. Y.
Eber, M., Westinghouse Lamp Division, Bloomfield, N. J.
Ekstrom, L. P., Sperry Gyroscope Company, Incorporated, Brooklyn, N. Y.
Engel, J. S., Federal Telephone and Radio Corporation, Newark, N. J.
Ewing, J. H., Sperry Gyroscope Company, Incorporated, Brooklyn, N. Y.
Farber, V. O. (Member), Frank Adam Electric Company, New York, N. Y.
Feinman, G., Espey Manufacturing Company, Incorporated, New York, N. Y.
Fischer, L. G., Federal Telephone and Radio Laboratories, New York, N. Y.
Fitts, W. F., Westinghouse Electric Elevator Company, Jersey City, N. J.
Fortin, R. C., RCA Manufacturing Company, Incorporated, Harrison, N. J.
Fries, R. H. (Member), Underwriters' Laboratories, Incorporated, New York, N. Y.
Gallagher, B. A., Newark Signal Corps Inspection Zone, Newark, N. J.
Gammons, R. F., Signal Corps, Officers Quarters, Santender Apts., Asbury Park, N. J.
Gates, J. R., Radio Corporation of America, Harrison, N. J.
Geier, L. W., U. S. Army, Signal Corps, Electronics Training Group, c/o Postmaster, New York, N. Y.
Grossman, M., Industrial Scientific Corporation, New York, N. Y.
Hartwell, D. W., Submarine Signal Company, New York, N. Y.
Hastings, H. A., Eclipse Aviation Corporation, Bendix, N. J.
Hayes, J. E., Gielow, Incorporated, New York, N. Y.
Heider, E. A., 149 Hunterdon St., Newark, N. J.
Himmel, L., Federal Telephone and Radio Laboratory, New York, N. Y.
Holt, C. A., Signal Corps Ground Signal Service, Fort Monmouth, N. J.
Jakimowitz, J., United States Army Signal Corps, Newark, N. J.
Jennings, H. I., Arma Corporation, Brooklyn, N. Y.
Jensen, A., 825—70th St., Brooklyn, N. Y.
Joshi, N. R., Diehl Manufacturing Company, Finderne, N. J.
Kelly, T. S. (Member), 115 East 60th Street, New York, N. Y.
Kenlan, C. C. (Member), Electric Arc, Incorporated, Newark, N. J.
Kwong, Y. C., Free World, Incorporated, New York, N. Y.
Lessey, S. K. (Member), Electric Storage Battery Company, New York, N. Y.
Maloney, M. E., Bell Telephone Laboratories, Incorporated, New York, N. Y.
Markow, E. W., Federal Telephone and Radio Corporation, Newark, N. J.
Marzan, P. R., Signal Corps Laboratory, Fort Monmouth, N. J.
McHoney, L. M., Westinghouse Electric and Manufacturing Company, Bloomfield, N. J.
McKenna, F. A., Newark Signal Corps Inspection Zone, Newark, N. J.
Milliken, G. W., Long Island Lighting Company Glenwood Landing, L. I., N. Y.
Miner, W. A., Jr., Federal Telephone and Radio Company, Newark, N. J.
Momberg, J. W., Diehl Manufacturing Company, Finderne, N. J.
Moore, A. H., General Electric Company, New York, N. Y.
Moyer, R. B., Curtiss-Wright Corporation, Caldwell, N. J.
Murphy, G. G., Federal Telephone and Radio Corporation, Newark, N. J.
Muth, J., Jr., Espey Manufacturing Company, New York, N. Y.
Neill, C. L., RCA Victor Division, Radio Corporation of America, Harrison, N. J.
O'Connor, R. A., United States Signal Corps, c/o Western Electric Company, Kearny, N. J.
Pescatori, I. P., Burns and Roe, New York, N. Y.
Quick, D. M. (Associate re-election), Public Service Electric and Gas Company, Newark, N. J.
Rehberg, C. F., New York University, New York, N. Y.
Restaino, J. J., American Telephone and Telegraph Company, New York, N. Y.
Retzer, T. C., Camp Evans Signal Laboratory, Belmar, N. J.
Roeber, E. M., Wright Aeronautical Company, Paterson, N. J.
Samek, C. O., Jr., International Projector Corporation, New York, N. Y.
Schreiber, T. W. (Associate re-election), M. W. Kellogg, New York, N. Y.
Schriever, R. H., General Electric Company, New York, N. Y.
Shaw, V. G., Western Electric Company, Kearny, N. J.
Smith, C. P., RCA Manufacturing Company, Harrison, N. J.

Solzberg, S., Freed Transformer Company, New York, N. Y.
Sousa, J. J., Crocker-Wheeler Electric Manufacturing Company, Ampere, N. J.
Sullivan, J. F. (Member), Bendix Aviation Corporation, Brooklyn, N. Y.
Teague, A. G., United States Navy Yard, New York, N. Y.
Urbach, K., Federal Telephone and Radio Corporation, Newark, N. J.
Welke, R. A. (Member re-election), Pratt Institute, Brooklyn, N. Y.
Wilcox, R. C., RCA Manufacturing Company, Incorporated, Harrison, N. J.
Williams, R. B., 108 Fourth Street, Garden City, N. Y.
Witmer, J. J., Jr., Curtiss-Wright Corporation, Caldwell, N. J.
Woodbury, C. P., Sperry-Gyroscope Company, Incorporated, Brooklyn, N. Y.
Wolfson, W., United States Navy Yard, Brooklyn, N. Y.
Yoder, D. R., RCA Victor Division, Radio Corporation of America, Harrison, N. J.
Zdan, W., Western Electric Company, Incorporated, Kearny, N. J.

4. Southern

Akerman, J. A., Tennessee Valley Authority, Knoxville, Tenn.
Askew, J. D., Southern Bell Telephone and Telegraph Company, Atlanta, Ga.
Ballard, E. J., Jr., Tennessee Valley Authority, Knoxville, Tenn.
Branum, C. F., U. S. Army, Signal Corps, Camp Murphy, Fla.
Goldman, S. A., University of Miami, Coral Gables, Fla.
Hargroder, A. D., Mathieson Alkali Works, Incorporated, Lake Charles, La.
Keeler, E. M., Florida Power and Light Company, Miami, Fla.
Lapsley, J. W., Jr., Celanese Corporation of America, Narrows, Va.
Latimer, D. T., Jr., Tennessee Valley Authority, Knoxville, Tenn.
McLarn, R. H., Jr., United States Army, 253rd Sig. Cons. Co., Camp Claiborne, La.
Quinn, R. L., Aluminum Company of America, Alcoa, Tenn.
Ruvin, A. E., National Advisory Committee for Aeronautics, Langley Field, Va.
Sheppard, J. L. (Member), South Carolina Public Service Authority, Moncks Corner, S. C.
Sterner, E. E., Commonwealth & Southern Corporation, Birmingham, Ala.
Stricker, A. K., Jr. (Member), Signal Corps, Arlington, Va.
Swank, K. D., 727 Raleigh Avenue, Norfolk, Va.
Turner, J. A., Sr., Tampa Armature Works, Inc., Tampa, Fla.
Winckowski, B. F., Langley Memorial Aeronautical Laboratory, Langley Field, Va.

5. Great Lakes

Anthony, D. J., 404 Lake Shore Drive, Escanaba, Mich.
Austin, J. B., Jr., Mason and Hanger Company, Incorporated, Baraboo, Wisc.
Beling, G. D., Allis-Chalmers Manufacturing Company, Milwaukee, Wisc.
Bennett, R. C., I. A. Bennett and Company, Chicago, Ill.
Bilgesu, K. A., Chicago District Electric Generating Corporation, Hammond, Ind.
Birgelaitis, E. J., Allis-Chalmers Manufacturing Company, West Allis, Wisc.
Bracht, M. G., Jr., General Electric Company, Fort Wayne, Ind.
Breckenfelder, E. H., Naval Training School, Iowa State College, Ames, Iowa.
Bunce, H. B., Illinois Institute of Technology, Chicago, Ill.
Carpenter, E. P., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Carson, R. E., Tri-State College, Angola, Ind.
Crellin, J. L., Allis-Chalmers Manufacturing Company, Milwaukee, Wisc.
De Cenzo, V. V., United States Naval Ordnance Plant, Center Line, Mich.
Devoy, J. R., General Electric Company, Fort Wayne, Ind.
Donnelly, F., Jr. (Member), Commonwealth Edison Company, Chicago, Ill.
Forbes, L. N. (Member), Northern Indiana Public Service Company, Hammond, Ind.
Haney, R. L., Jr., Allis-Chalmers Manufacturing Company, Milwaukee, Wisc.
Irving, L. G., 6 Munger Terrace, Duluth, Minn.
Kelsey, J. R., Telex Products Company, Minneapolis, Minn.
Kinser, J. W., Commercial Solvents Corporation, Terre Haute, Ind.
Lichty, J. R., General Electric Company, Ft. Wayne, Ind.
Ling, K. S., Continental Electric Company, Geneva, Ill.
McIntosh, D. H., Allis-Chalmers Manufacturing Company, Milwaukee, Wisc.
Oksanen, R. O., Allis-Chalmers Manufacturing Company, West Allis, Wisc.
Pause, H. A. (Member), American Telephone and Telegraph Company, Chicago, Ill.
Pendlebury, H. G., Kellogg Switchboard and Supply Company, Chicago, Ill.
Pfandhoefer, H. J. (Member), General Electric Company, Chicago, Ill.
Pollack, M., Illinois Institute of Technology, Chicago, Ill.
Sanden, L. H., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Scudder, F. W. (Member), American Telephone and Telegraph Company, Chicago, Ill.
Sikorra, D. J., Allis-Chalmers Manufacturing Company, Milwaukee, Wisc.
Steele, C. E., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Vanden Hoek, J. A., General Motors Corporation, Grand Rapids, Mich.
Verch, W. H., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Williams, T. D., Allis-Chalmers Manufacturing Company, Milwaukee, Wisc.
Wright, W. H., Indiana and Michigan Electric Company, South Bend, Ind.
Yamakawa, K. A., Grinnell College, Grinnell, Iowa.
Young, R. A., Automatic Electric Co., Chicago, Ill.
Zankl, F., Kearney and Trecker Corporation, West Allis, Wisc.

6. North Central

Henson, H. H., Rocky Mountain Arsenal, Denver, Colo.
Kappel, F. R. (Member), Northwestern Bel Telephone Company, Omaha, Neb.
McEnany, M. V., South Dakota State College, Brookings, S. D.
Osborne, R. H., United States Engineer Corps, Denver, Colo.
Robertson, R. D., 728 Vine Street, Denver, Colo.
Vercellino, F. D. (Member), Western Union Telegraph Company, Dickinson, N. D.

7. South West

Allison, D. M., Westinghouse Electric and Manufacturing Company, St. Louis, Mo.
Berman, G., 1010 E. Broadway, Sweetwater, Tex.
Buchan, R. L., Union Electric Company of Illinois, St. Louis, Mo.
Carmean, J. H. (Member), Black and Veatch, Kansas City, Mo.
Cooper, G. V., El Paso Electric Company, El Paso, Tex.
Cruise, R. B., Gulf States Utilities Company, Beaumont, Tex.
Fahrenthold, P. C., Lower Colorado River Authority, Austin, Tex.
Gates, L. A., U. S. Cartridge Company, St. Louis, Mo.
Green, C. R., Beech Aircraft Corporation, Wichita, Kan.
Gruner, J. E. (Associate re-election), Union Electric Company of Missouri, St. Louis, Mo.
Hanson, G. B. (Member), Petroleum Rectifying Company, Houston, Tex.
Hickey, D. H., General Electric Company, El Paso, Tex.
Hickman, F. B., Westinghouse Electric and Manufacturing Company, St. Louis, Mo.
Holway, D. K., W. R. Holway and Associates, Tulsa, Okla.
Hulett, W. E., Dora, Mo.
Lewis, C. G., C. B. Fall Company, St. Louis, Mo.
McKee, D. E. (Associate re-election), City of Fort Worth, Engineering Department, Ft. Worth, Tex.
Miller, J. M. (Member), E. B. Badger and Sons Company, Baytown, Tex.
Ostman, H. F., Union Electric Company of Missouri, St. Louis, Mo.
Pouppirt, W. C., Phillips Petroleum Company, Bartlesville, Okla.
Reed, L. B., Naval Air Station, Dallas, Tex.
Shepperd, W. B. (Member), University of Kansas, Signal Corps Training, Lawrence, Kan.
Sholders, F. M., Graybar Electric Company, Kansas City, Mo.
Weiser, C. H., Southwestern Bell Telephone Company, Kansas City, Mo.

8. Pacific

Cartmell, R. N., Westinghouse Electric and Manufacturing Company, San Francisco, Calif.
Chilton, W. F., Kaiser Company Incorporated, Richmond, Calif.
Conner, J. P. (Member), Headquarters 11th Naval District, San Diego, Calif.
De Carli, V. L., Mare Island Navy Yard, Mare Island, Calif.
Dishington, R. H., Bendix Aviation Limited, Hollywood, Calif.
Dysart, R. R. (Member), United States Maritime Commission, Oakland, Calif.
Foy, R. H., Box 62, Boulder Creek, Calif.
Gantvoort, W. F. (Associate re-election), Joshua Hendy Iron Works, Sunnyvale, Calif.
Kunigonis, P. T., United States Army, c/o Postmaster, San Francisco, Calif.
Misner, L. H., Advanced Naval Training Schools, Treasure Island, San Francisco, Calif.
Persohn, J. W., United States Army, 654th Sig. A. W. Rep. Co., Los Angeles, Calif.
Riggins, H. C., Consolidated Steel Corporation, Limited, Wilmington, Calif.
Rips, J. L., Consolidated Aircraft Corporation, San Diego, Calif.
Seloy, M. F., Aluminum Company of America, Los Angeles, Calif.
Sherman, L. M., Douglas Aircraft Company, Incorporated, Santa Monica, Calif.
Wong, H. F., United States Navy Yard, Mare Island, Calif.
Zarem, A. M., California Institute of Technology, Pasadena, Calif.

9. North West

Coffin, C. J., Boeing Aircraft Company, Renton, Wash.
Cooley, R. D., Puget Sound Navy Yard, Bremerton, Wash.
Eckels, D. J., Columbia Steel Company, Provo, Utah.
Hart, S. V. (Member), Associated Shipbuilders, Seattle, Wash.
Johnson, W. (Associate re-election), Bonneville Power Administration, Portland, Ore.
Russell, C. (Associate re-election), Willamette Iron and Steel Company, Portland, Ore.

10. Canada

Austin, W. R., Industrial Timber Mills Limited, Youbou, B. C.
Bailey, J. C., Canadian General Electric Company, Toronto, Ontario.
Bundy, L. P., English Electric Company of Canada, St. Catharines, Ontario.
Challies, J. B. (Associate re-election), The Shawinigan Water and Power Company, Montreal, Quebec.
Chu, G. D., National Research Council, Ottawa, Ont.
Davie, H. S., Naval Service, 408 Marine Building, Vancouver, B. C.
Dowsley, C. L., Burrard Drydock Company, Limited, North Vancouver, B. C.
Greene, P. W., Canadian General Electric Company, Limited, Toronto, Ontario.
Hills, J. F., National Research Council, Vancouver, B. C.
Horning, L. R., R.C.N.V.R., D/G Office, H.M.C. Dockyard, Halifax, N. S.
Malchow, M. E., Canadian Marconi Company, Montreal, Quebec.
Phillips, R. E., University of Alberta, Edmonton, Alberta.

Total, United States and Canada, 391

Elsewhere

Dueno, B. (Member), College of Agricultural and Mechanical Arts, Mayaguez, Puerto Rico.
Dyer, J. P., Jr., Lago Oil and Transport Company, Limited, Netherlands, West Indies.
Irens, A. N. (Member), Bristol Aeroplane Company, Bristol, England.
Kumar, P., Foster Transformers and Switchgear Limited, South Wibledon, S.W. 19, England.
Munguia, A. A., 12 506, Vedado, Habana, Cuba.
Reeves, C. J. (Member), Messrs. Fisher and Ludlow Limited, Birmingham, 5, England.

Total elsewhere, 6

Addresses Wanted

A list of members whose mail has been returned by the postal authorities is given below, with the addresses as they now appear on the Institute record. Any member knowing of corrections to these addresses will kindly communicate them at once to the office of the secretary at 33 West 39th St., New York, N. Y.

Abell, E. D., 1168 Glenwood Blvd., Schenectady, N. Y.
Allen, Hugh Silas, Jr., Naval Research Laboratory, Washington, D. C.
Cadet J. B. Anderson, Class 41–5, Chanute Field, Ill.
Bean, William S., Jr., 1108 Baker Ave., Schenectady, N. Y.
Beasley, O. A., 901 N. Olive St., West Palm Beach, Fla.
Bowman, J. Y., 3430 Asbury, Dallas, Texas.
Brady, Gordon F., 19 Arlington St., Pittsfield, Mass.
Brown, Lieut. Raymond L., Fort Michie, N. Y.
Caplan, Norman, A-C Detachman, Scott Field, Ill.
Carlson, Robert L., 1783 N. El Molino, Pasadena, Calif.
Chamberlin, John R., Jr., Box 27, Mariaville Lake, N. Y.
Coon, R. Marshall, 1649 Good Hope Road, Washington, D. C.
De Pew, Reo T., 921 Eastwood Ave., Chicago, Ill.
Ford, J. H., Naval Training School, Bowdoin College, Brunswick, Maine.
Gable, James G., 6953 Edgerton Ave., Pittsburgh, Pa.
Goodrich, F. B., 100 Lincoln Ave., Riverside, Ill.
Gretz, Clarence B., 2307 Calvert St., N. W., Washington, D. C.
Guerrieri, Joseph, General Delivery, Glendale, Calif.
McGillivray, Archie, 1318 Singer Place, Wilkinsburg, Pa.
Nason, E. Paul, 1060 Pearl St., Sharon, Pa.
Osterberg, Edward K., 325 Monroe St., Gary, Ind.
Pearman, M. N., 3433 Hanover Ave., Richmond, Va.
Schlieder, Harold A., Box 423, Erie, Pa.
Taylor, James Albert, Jr., 64 Commonwealth Ave., Pittsfield, Mass.

24 Addresses Wanted

OF CURRENT INTEREST

Schenectady Engineers Discuss Civic Affairs

Discussing common problems concerning the administration of municipal affairs with a view to arousing civic interest among engineers, Alan Wood Hastings, director of the Department of Public Works, Montclair, N. J., addressed a recent meeting of the Co-ordinated Engineering Societies of Schenectady, N. Y., on "Civic Engineering in Montclair." The AIEE Schenectady Section is one of the co-operating groups comprising the Co-ordinated Societies.

This meeting was planned as a follow-up of the ideas given in the March 1942 issue of *Electrical Engineering* on the organization of local engineering councils, and Mr. Hastings was reporting on the progress of good government in Montclair and the nonpartisan citizen's organization which made it possible. Although not primarily an engineering group, because of the character of many of the problems involved, the percentage of engineers in the membership ran high.

The leading citizens of the town who formed the Montclair Association first thought to eliminate wasteful and chaotic expenditure for municipal improvements by effecting the unification of the management of town affairs. This they hoped to accomplish by a change from the commission to the city-manager form of local government. They were defeated in 1934, by a small majority, but two years later were able to impose four of their own candidates on the existing commission system, with its five departments. Backed politically, they were able then, to prevent the letting of new contracts for public works to undesirable political elements, and could initiate investigations into the maintenance of established public conveniences.

Among the projects prosecuted were the rehabilitation of the water system, with a great saving to the town in the operating cost of pumping and the reduction of insurance premiums because of better fire protection; the repaving of 15 miles of streets; the purchase of new fire equipment, replacing some over thirty years old and thereby reducing insurance costs; the installation of a new street-light system putting four times as much light on the streets for the same annual cost to the town; the setting up of a town refuse collection; beneficial changes in zoning laws; the reappraising and reassessing of all property in the town, and the establishment of a recreational program. One of their greatest accomplishments was putting the town finances in order.

Much of the business of the organization was transacted by citizen advisory committees, such as the civics committee of the Montclair Society of Engineers. Recently, the defense council enlisted 4,000 citizens in defense activities, representing ten per cent of the total population of Montclair. This figure is significant of the power of a civicly aroused community.

Mr. Hastings pointed out that the Montclair program had succeeded because of its strong organization, its constant and active publicity, and the self-sacrifice of the leaders. He expressed the belief that any community, given these three factors, should be able to achieve civic improvements.

Former AIEE Member Dies

Walter J. Branson, retired designing and research engineer, died in Philadelphia, Pa., on November 13, 1942. A graduate of the University of Pennsylvania in 1898 with the degree of doctor of philosophy in social and political science, he turned to engineering after he discovered that only in this field could he satisfy his scientific and analytic ability. He was active for many years, first with Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa., and later with the Robbins and Myers Company, Springfield, Ohio, in the design of fractional horsepower a-c motors of the split-phase type, and polyphase induction motors. In two AIEE papers (published in the AIEE *Transactions* of 1912 and 1929, respectively) he presented practical systems of calculation as to the accuracy of performance of such motors. He became an associate member of AIEE in 1912, but resigned in 1931.

WAR PROGRAM • •

Specialists Needed by Military Government Division

Men, aged 35 to 55, highly skilled, with good basic education and broad administrative or executive experience in several professional fields, including that of electrical engineering, are wanted by the Military Government Division of the Provost Marshal General's Office, according to a memorandum issuing from that office.

The Institute has been asked to receive indications of interest accompanied by a summary of professional, educational, technical, and practical experience. These should be addressed to C. H. Sanderson, secretary, AIEE committee on co-operation with war agencies, 4 Irving Place, New York, N. Y. Information thus received will be forwarded promptly to the appropriate officer. Formal application blanks will be issued to inquirers from the Provost Marshal General's Office at a later date.

The memorandum explains that a "specialists' pool" is being created, the members of which will be appointed in the Officers Reserve Corps, ultimately to be called to active duty in the military government of hostile areas occupied by American armed forces, when their services will be required. Information regarding physical examinations, ranks, pay, and other details, are not yet announced.

To be eligible for a commission applicants must have had a good basic education and broad administrative or executive experience in government with a state, county, city, or federal department, or as experts in public works, public health, sanitation, public safety, education, communications, public relations, public welfare, finance, or economics. Importance is attached to demonstrated administrative and executive ability, and to knowledge of foreign countries and foreign languages.

It is anticipated that all such reserve officers will be called to active duty at government expense for a period not exceeding four months for training, consisting of basic indoctrination and principles of military government. A small number of those commissioned may be selected to attend the School of Military Government at the University of Virginia, Charlottesville.

Qualifications are defined as ability to deal effectively with important government and military officials; to get along well with persons of all types and strata of society; to handle difficult situations and problems; to express one's self forcefully and clearly; to be possessed of tact, diplomacy, understanding of social behavior and attitudes, imagination and adaptability.

Graduation from a recognized professional school will be waived only in excep-

Future Meetings of Other Societies

American Chemical Society. Spring convention, April 12–16, 1943, Detroit, Mich.

American Railway Engineering Association. Annual Convention, March 16–18, 1943, Chicago, Ill.

American Society of Mechanical Engineers. Spring meeting, April 26–28, 1943, Davenport, Iowa; semiannual meeting, June 14–16, 1943, Los Angeles, Calif.

American Society for Testing Materials. Spring meeting, March 2–5, 1943, Buffalo, N. Y.; annual meeting, June 28–July 2, 1943, Pittsburgh, Pa.

American Society of Tool Engineers. Annual meeting, March 25–27, 1943, Milwaukee, Wis.

Annual Safety Convention and Exposition. 14th meeting, March 23–25, 1943, New York, N. Y.

Electrochemical Society. April 7–10, 1943, Pittsburgh, Pa.

Midwest Power Conference. Annual meeting, April 9–10, 1943, Chicago, Ill.

National Electrical Manufacturers Association. Spring meeting, April 20–23, 1943, Chicago, Ill.

National Fire Protection Association. May 10–14, 1943, Chicago, Ill.

tional cases. All candidates must have had at least five years' experience in an important administrative position involving broad executive experience.

Navy Needs Binoculars

The submarine menace has created a tremendous demand for high-powered binoculars for use by the air, surface, and submarine services of the United States Navy. Production of these glasses is lagging far behind the need, with the present level of supply failing to meet the demand by about 7,000 pairs. To alleviate this shortage immediately, while the process of stepping up production is under way, an appeal is being made to owners of fine binoculars to lend them to the war effort. Those wishing to assist in this way should send their glasses to the Bureau of Ships, Washington, D.C. There they will be examined and tested by the Naval Observatory; if accepted, they will be engraved with the name and address of the owner and returned at the end of the war. A check for $1.00 and a covering voucher is issued by the Navy as compensation or rent.

INDUSTRY.....

Electrical and Mechanical Firms Merge

The Joshua Hendy Iron Works of Sunnyvale, Calif., has recently expanded its production facilities to include the Pomona (Calif.) Pump Company, with its subsidiary, the Westco Pump Division, and the Crocker-Wheeler Electric Manufacturing Company of Ampere, N. J., according to an announcement from Charles E. Moore, president. The merger of interests reflects a combined total of 140 years of continuous progress and varied specialization in the mechanical and electrical fields, and was effected in an effort to match engine production to the pace of ship launchings on the west coast.

The California plant, expanded to cover more than 60 acres of ground, has been converted from job-shop production of triple-expansion steam engines in World War I to mass production of the same.

The Crocker-Wheeler plant, already engaged in production of motors and control equipment for the war effort, will be expanded under the management of A. J. M. Baker, and will supplement the production of the Hendy line with turbogenerators, motors, and other electrical equipment. To relieve additional bottlenecks in shipbuilding, the Pomona Pump Company, under the supervision of George A. McKenna, has been commissioned to continue with their design, manufacture, and application of a wide range of types and kinds of pumps. In addition to the two existing plants of this company, a new 25-acre plant in California has been procured to aid this manufacture.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without letter, the other lettered. Captions should be supplied for all illustrations.

A Suggestion for Saving Power—Series Versus Multiple Lighting

To the Editor:

Mr. William A. Crow has raised several questions in his letter published in the January 1943 issue of *Electrical Engineering*, pages 48–9, regarding my statements in the October 1942 issue, pages 543–4, relative to the merits of multiple versus series street lighting. He takes exception to two specific items: the loss of 40 to 44 per cent in the series-lighting circuit and the cost of $96 per kilowatt for transformers and associated equipment serving series-lighting circuits. I believe that the subject has sufficient general interest to require an answer to these questions and I would like to supply some of the background leading up to the above figures.

In March 1941, the Village of Roslyn on Long Island instituted a street lighting rate case against the Long Island Lighting Company. The proceedings were carried on before a trial examiner of the New York Public Service Commission and were designated as case 10,388. The writer acted as consulting engineer for the village. During the hearings one of the engineering witnesses for the lighting company testified that the total energy sold for street lighting in 1940, calculated at the powerhouse, equalled 18,794,672 kilowatt-hours while the energy consumed at the actual lamps, using the lamp ratings and the average hours use throughout the year, equalled 13,041,793 kilowatt-hours. The difference of 5,752,879 kilowatt-hours equals 44.1 per cent of the energy consumed at the lamps. These figures are shown in the company exhibit 20, submitted at the hearing on October 24, 1941. This is, to put it mildly, a ghastly situation! There is no other type of commercial circuit where the losses even remotely approach such a figure.

This is not an isolated case. In 1939 the writer had occasion to participate in the street lighting rate case initiated by the City of Long Beach on Long Island against the Queens Borough Gas and Electric Company (New York Public Service Commission case 8,403). This case presented an opportunity to make calculations of the losses in both series and multiple street-lighting circuits. For the multiple circuits the loss on the basis of delivered energy at the lamps equalled 5.4 per cent. This was from the primary side of the distribution transformers to the lamps. For the series circuits the corresponding loss was 27.3 per cent, over five times as much. These series circuits were all supplied by *RO* and *ROC* transformers located out on the line so that there was no excessive conductor resistance involved. And the lamp spacings were about the same in both cases. It stands to reason that where you introduce *RO* transformers and *SL* transformers and *IL* transformers whose efficiencies drop off very sharply when they are not fully loaded, the resulting over-all losses are going to exceed greatly those in circuits supplied by the ordinary distribution transformers. These quoted figures are realities, not theory. It is believed other companies would show the same results if the calculations were ever developed. Voltage regulation has little bearing on the matter. The introduction of radio receivers has compelled the lighting companies to maintain uniform and adequate voltage on distribution lines which compares favorably with regulations on series circuits.

The figure of $96 per kilowatt for transformer capacity quoted in my letter in the October 1942 issue of *Electrical Engineering* was an estimate applicable only to the Village of Roslyn and represented assumptions of ideal conditions. It is believed that a much fairer figure would be the corresponding cost for the entire company system. The lighting company has supplied such data (pages 498, 476, 703, and 952 of the stenographer's minutes of the case). The cost of all street-lighting equipment in substations (essentially transformers and related equipment such as meters and time switches) and series transformers on the lines totalled $320,904. In addition there was a total of 7,100 *IL* transformers which the writer estimated at a cost of $21.76 each, or a total of $154,496. The sum total of both figures is $475,400. The street-lighting demand at the lamps, a figure also supplied by the lighting company, was 3,553 kw. This results in a cost of $134 per kilowatt for transformer capacity including the Novalux controllers and protectors and all *IL* and *SL* transformers.

None of these fancy devices is needed with multiple street-lighting circuits. A simple relay in "cascade" connection could handle up to eight lamps of fairly large candle power. And these relays are relatively inexpensive and easy to maintain. In addition, the first cost of lamp fixtures and lamps would be greatly reduced, as they would have a much lower voltage rating. And it would not be necessary to energize the lamp circuits over miles of territory in the daytime in order to replace burnt-out lamps. A

break in the series wire renders an entire circuit inoperative and may plunge the streets of a whole community into darkness. Not so with multiple street lighting. The only disadvantage would be that a multiple lamp requires about 25 per cent more wattage than a series lamp of the same candle power. However, if an outdoor type of fluorescent lamp is developed the current would be sharply decreased.

Mr. Crawford, in his article, "Inventors, Patents, and the Engineer" (*EE, Jan. 1942, pp. 11–16*) says "The traditionally natural or human action is to cling to the old and resist the new." That should not be the case in street lighting. If power rationing is ever required, series street lighting should be put at the very top of the list. At the end of the war if the construction departments of utilities lack work, the complete change of series to multiple lighting is suggested. This would enable utilities to make reductions in street-light rates and perhaps thus direct the minds of local municipal officials from the possible installation of Diesel engines for publicly owned power plants. The manufacturers of improved Diesel engines after the war will be seeking aggressively new markets and villages and towns will provide a fertile field.

L. MACKLER (M '24)
(Consulting engineer, New York, N. Y.)

Cooling Error in Transformer-Temperature Measurement

To the Editor:

In testing transformers, the standard method of determining winding temperature consists of measuring winding resistance at short intervals of time following shutdown, then plotting the readings and projecting them back to the instant of shutdown. The resistances are usually measured by the voltmeter-ammeter or by a bridge. In either method a d-c power source is applied to the circuit, directly or through a resistor.

Since the transformer winding is cooling, its resistance is changing, and the current in the measuring circuit is also changing, assuming constant-voltage power supply and a series resistor of constant value. Since the winding is inductive, this changing measuring current introduces errors, because $L\, di/dt$ voltages are being included in the ir drops. The measured resistances are therefore too high. Moreover, since the cooling rate is continually decreasing, the individual errors become progressively less, and the plotted curve will have too steep a slope. The error in derived temperature at shutdown is thereby increased.

There are many cases in which this error is not worth attention, but there are others in which its amount may be substantial. It can be shown that the error in degrees centigrade represented by an individual resistance measurement is nearly equal to $LK/60R$, where L is the incremental inductance of the winding at the measuring current, in henrys, K is the cooling rate of the winding in degrees centigrade per minute, and R is the total resistance of the measuring circuit, in ohms.

Oscillograms taken on a 24-kv, 7,500-kva, 60-cycle wye winding show it to have a maximum inductance of about 500 henrys. Assuming this to be a representative value, and since reactance varies directly as the voltage and inversely as the frequency rating of windings, the preceding relation can be written:

Maximum cooling error, degrees centigrade = $20EK/RF$, approximately, where E is the kv rating of the winding at a frequency of F cycles per second. Values of K usually range from 1 to 10, depending on transformer construction, type of cooling, and per cent of rated load that has been applied. In actual cases the cooling error may amount to several degrees, and the unit then is unjustly penalized.

One way to reduce the error is to employ a high enough current to saturate the core. Referring again to the 7,500-kva unit, raising the measuring current from 0.2 to 2.0 amperes decreased the incremental inductance from 500 to 10 henrys. The cooling error would thus be reduced by a factor of 5. The inductance of this winding, on the basis of its 60-cycle magnetizing current, is about 10 henrys.

It may be pertinent to remark that the constancy requirements imposed on the source voltage of the measuring circuit and on the series resistor (if one is used), are severe, and that errors resulting from inconstancy may be relatively large. The measuring current generally decreases in such cases, causing measured winding temperatures to be too low, whereas cooling error results in too high a determination.

FREDERICK BAUER (A '42)
JEROME J. TAYLOR (A '40)
(Detroit (Mich.) Edison Company)

Transmission-Line Equations

To the Editor:

The letter of Mr. V. J. Cissna in the November 1942 issue of *Electrical Engineering*, page 587, is of interest to the writer, who has also noted the difficulty commented upon and would like to make some suggestions. Mr. Cissna has really put three questions which will be dealt with separately. The first concerns the differing signs in the two pairs of general equations; the second concerns the interchanging of the A and D constants; and the third concerns the physical significance of these A and D constants.

As regards the first, the writer is of the opinion that this difficulty arises because of a lack of generality in the considerations which lead to the usual equations. This lack of generality is brought about by referring to one end of a circuit as the "receiving" end and the other end as the "sending" end, a practice which the writer now has abandoned completely and which hes trongly deprecates. This practice appears to have grown up in the past when transmission circuits were more often used for power transmission in one direction only—a situation which introduces restraints on the more general and more modern practice in which most circuits are, in effect, tie lines or interconnectors between two sources of generated power, and the writer, in conjunction with Mr. C. G. Carrothers, has already drawn attention to this elsewhere (British Institution of Electrical Engineers *Journal*, volume 89, 1942, part II, page 373).

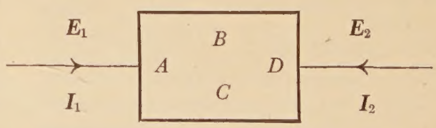
If a circuit is considered to have generating plant connected at one end only, then it is perhaps admissible to regard as positive a "sending" current at the end to which the generating plant is connected and, simultaneously, to regard as positive a "receiving" current at the other end, as is done in the accepted theory. But once the general case with generating plant at both ends is considered, it is much more logical to regard a "sending" current as positive, no matter at which end it occurs. Mature consideration shows that this convention, which is shown in the diagram, has every advantage even though it may appear that current flowing into the circuit from both ends simultaneously is rather removed from normal conditions. Suffice it to say, however, that this condition does in fact occur when the voltages applied at the two ends are equal in magnitude and have zero phase displacement.

The vector equations for the quantities at end 1 in terms of the conditions at end 2 can then be written:

$$E_1 = AE_2 - BI_2 \qquad (1)$$

$$I_1 = CE_2 - DI_2 \qquad (2)$$

and they completely specify the conditions at that particular end, whether it happens to be "sending" or "receiving." It follows that if I_2 is "sending" (positive) and $DI_2 < CE$, then I_1 will also be "sending," but if $DI_2 > CE_2$, then I_1 will be "receiving." If, however, I_2 is "receiving" (negative) then I_1 must be "sending," no matter what the value of I_2 happens to be.



The accompaning diagram shows the direction of currents for positive values.

Again the conditions at end 2 can be expressed in terms of end 1 by rearranging equations 1 and 2 and noting that $AD - BC = 1$, in which case,

$$E_2 = DE_1 - BI_1 \qquad (3)$$

$$I_2 = CE_1 - AI_1 \qquad (4)$$

and these equations completely specify

the conditions at this end no matter whether it is "sending" or "receiving." Mr. Cissna will, no doubt, be pleased to note that these equations are very similar to his equations 15–18 inclusive, except that his ± and ∓ have now been avoided. There is, moreover, no difference in the signs of the two pairs of equations, which thus removes this difficulty and the equations now show that the circuit conditions are in fact quite independent of the direction of power flow, as Mr. Cissna points out that they should be.

On the other hand, the constants A and D have changed places, but this is because these two constants are in fact functions of the physical construction of the circuit and by converting equations 1 and 2 into the form 3 and 4, we have, in effect, removed our interest to the other end of the circuit at which conditions are physically different.

As far as the writer is aware, there is no way of surmounting this, the second point raised by Mr. Cissna. Disposing of the sign difficulty and adopting the notation shown on the diagram does, however, make it quite easy to write down the equations for either end by remembering that the voltage multiplier for the other end voltage in the voltage equation is shown nearest to the end for which the equations are being written; for example, in the equation for E_2, E_1 has to be multiplied by the constant nearest E_2, namely D.

As to the last point raised by Mr. Cissna, the writer has not any decided opinion to offer but confirms that these constants are, in fact, the effective current and voltage ratios. It may help to recall that, just as for a single series impedance Z and, alternatively, for a single shunt admittance Y, the values of the constants are respectively,

$$A = 1 \quad B = Z \quad C = 0 \quad D = 1$$

and

$$A = 1 \quad B = 0 \quad C = Y \quad D = 1$$

so also for a perfect transformer of turns ratio n, the values are

$$A = n \quad B = 0 \quad C = 0 \quad D = 1/n$$

The writer would like to remark on one further point. It is that while the ends of the circuit have been referred to as "1" and "2" in the treatment herein, reference to his previous remarks will show that he has adopted generally the use of the terms "near" and "far" to distinguish the two ends. The use of "1" and "2" in this instance was advantageous in order to show the similarity between the writer's treatment and Mr. Cissna's conclusions and is perhaps generally preferable when one is considering a circuit in abstract or, one may say, from halfway along it, from a geographical point of view. Even then, "a" and "d" might alternatively be used in order to associate the physical ends with the constants A and D. In actual practice, however, a circuit is perhaps most often considered by staff physically located at one end of it and actually concerned with the operation of it. In this case, the terms "near end" and "far end" and the resulting abbreviations, for example E_n and E_f, are particularly appropriate as also are they when constructing and using transmission line charts to which the writer's previous remarks specifically applied.

Finally, the writer would like to convey his greetings to electrical engineers in America and to hope that these suggestions will bring forth useful comment from the other side of the Atlantic.

P. d'E. STOWELL
(City of Edinburgh Electricity Department, Scotland)

To the Editor:

The point made by Mr. Cissna in his letter to the editor in the November issue of *Electrical Engineering*, page 587, will appeal to many engineers interested in transmission problems. The equations 15–18 cited by Mr. Cissna appear to be an important advance on any previously published. As Mr. Cissna explains, those equations are designed to express the line characteristics with complete generality. In view, however, of the vector notation used, would it not be possible to prescribe the direction of positive flow and to dispense with the ± signs? If, for example, it is agreed that positive current flows to the other end of the line from the end of the line designated by the suffix of the current symbol the signs become fixed and there is no loss either of symmetry or generality.

Perhaps Mr. Cissna's requirement that the equations should be presented in general form might be achieved with the least possible disturbance to existing notation by retaining the suffixes R and S while discarding reference to them as "receiving" and "sending". It is noteworthy that Mr. Cissna uses neither of these terms. The transmission equations for a line R/S would then become:

$$E_S = E_R A - I_R B \tag{1}$$

$$I_S = E_R C - I_R D \tag{5}$$

$$E_R = E_S D - I_S B \tag{6}$$

$$I_R = E_S C - I_S A \tag{4}$$

The numbers on the right are the references given by Mr. Cissna to the corresponding equations in their original form. It should be noted that I_R signifies a current from R to S and I_S a current from S to R.

The vector notation implies that the currents and voltages may have any phase relationship, a condition which is only practically possible when there is generating plant at each end of the line. In view of the fact that the line characteristics are independent of the position of the generating plant, this does not appear to invalidate the general equations.

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NEW BOOKS . . .

The following new books are among those recently received from the publishers. Books designated ESL are available at the Engineering Societies Library; these and thousands of other technical books may be borrowed from the library by mail by AIEE members. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books. All inquiries relating to the purchase of any book reviewed in these columns should be addressed to the publisher of the book in question.

Chemistry of Engineering Materials. By R. B. Leighou, rewritten by the following members of the chemistry faculty of the Carnegie Institute of Technology: J. C. Warner (editor), T. R. Alexander, P. Fugassi, D. S. McKinney, H. Seltz, G. H. Stempel, Jr., and K. K. Stevens. 4th edition, McGraw-Hill Book Company, New York, N. Y., and London, England, 1942. 645 pages, illustrations, etc., 9½ by 6 inches, cloth, $4.50. (ESL).

The chemical properties of materials are discussed from the viewpoint of the user, to aid in their intelligent selection and use. This edition has been enlarged by new chapters on protective coatings, the shaping of metals, abrasives, glass and organic plastics, and alloys.

Audel's Mathematics and Calculations for Mechanics, a Ready Reference. By F. D. Graham. Theodore Audel and Company, New York, N. Y., 1942 reprint, Sections *A*, *B*, *C*, *D*. 700 pages, illustrations, etc., 6½ by 5 inches, fabrikoid, $2. (ESL).

Section *A* of this reference manual constitutes an elementary text on mathematics covering simple arithmetic, plane, solid, spherical, descriptive, and analytical geometry, trigonometry and algebra, with a brief introduction to the calculus. Sections *B* and *C* deal with practical electrical and mechanical calculations. In Section *D* the principle and applications of the ordinary slide rule are explained.

Ultrahigh-Frequency Techniques. By J. G. Brainerd, G. Koehler, H. J. Reich, L. F. Woodruff. D. Van Nostrand Company, New York, N. Y., 1942. 534 pages, illustrations, etc., 9½ by 6 inches, cloth, $4.50. (ESL).

In 1941 a conference of representatives of colleges and universities met to consider the problem arising from the lack of sufficient men trained in electrodynamics and ultrahigh-frequency techniques to meet war demands. A uniform special course to be given to seniors in electrical engineering and physics at certain universities was outlined and arrangements made to prepare a textbook for this course. This book has been published to serve that purpose.

Science in Progress. By H. Shapley, E. Hubble, H. A. Bethe, V. K. Zworykin, P. W. Bridgman, L. S. Marks, J. Franck, J. G. Kirkwood, P. H. Long, H. Mark; edited by G. A. Baitsell. 3d series. Yale University Press, New Haven, Conn.;

Humphrey Milford, Oxford University Press, London, England, 1942. 322 pages, illustrations, etc., $9^1/_2$ by 6 inches, cloth, \$3. (ESL).

Contains ten lectures by scientists who discuss the results of recent research work in various scientific fields. The subjects considered in this volume include: galaxies, the expanding universe, energy production in the stars, image formation by electrons, recent work in high pressures, power generation, photosynthesis, the structure of liquids, sulfanilamide, and synthetic rubber.

Audel's Electronic Devices and Their Application. By E. P. Anderson. Theodore Audel and Company, New York, N. Y., 1942. 206 pages, illustrations, etc., 7 by $4^1/_2$ inches, fabrikoid, \$2. (ESL).

The purpose of this book is to supply working knowledge in the field of electronics where the photoelectric tube is a component part. Following a chapter on electronic fundamentals are chapters which describe and discuss photoelectric cells, vacuum tubes and phototube amplifiers, and relays. The application of electronic devices for practical purposes is considered also.

Frequency Modulation. By August Hund. McGraw-Hill Book Company, Inc., New York, N. Y., London, England, 1942. 345 pages, 6 by 9, \$4.

This text is intended for both the student of radio communication and the practicing engineer. Frequency modulation is described by comparison with phase and amplitude modulation. Chapters on apparatus deal with auxiliary apparatus, transmitters, receivers, and transmitter and receiver aerials. Such apparatus now being manufactured is compared and criticized.

Science Remakes Our World. By James Stokley. Ives Washburn, New York, N. Y., 1942. 288 pages, illustrated, \$3.50.

The history of the recent advances of the laboratory as they affect the every-day material welfare of the individual citizen and the trend of future experimentation are presented here in non-technical language. Developments in the manufacture of explosives, plastics, chemical clothes, radio, motion pictures, fuel, glass, and rubber are covered, as well as chemical research affecting food and drugs.

Electrical Fundamentals of Communication. By A. L. Albert. McGraw-Hill Book Company, New York, N. Y., and London, England, 1942. 554 pages, illustrations, etc., $9^1/_2$ by 6 inches, cloth, \$3.50. (ELS).

Intended as an elementary text for students of communication engineering, including telegraph, telephone, and radio, this book presents the electrical fundamentals upon which these forms are based. The explanations and illustrations used are taken from the communication industry itself, not from the power industry.

Seven-Place Values of Trigonometric Functions for Every Thousandth of a Degree. Compiled by J. Peters. D. Van Nostrand Company, New York, N. Y., 1942. Tables, $9^1/_2$ by 7 inches, cloth, \$7.50. (ESL).

These tables are intended for use in large scale computations with calculating machines. Tables are provided for sines, cosines, tangents, and cotangents. Supplementary tables are given for converting minutes and seconds into decimal parts of degrees, and vice versa, and for converting degrees to time and time to degrees.

Applied Nuclear Physics. By E. Pollard, W. L. Davidson, Jr., John Wiley and Sons, New York, N. Y.; Chapman and Hall, London, England, 1942. 249 pages, illustrations, etc., $9^1/_2$ by 6 inches, cloth, \$3. (ESL).

The technical aspect of the subject is emphasized in this book, which aims to present the essential facts and methods of artificial radioactivity and transmutation in a way that will be of service to chemists, engineers, and others who use the products of nuclear physics in their own spheres of work.

College Physics. By Henry A. Perkins. Revised edition. Prentice-Hall, Inc., New York, N. Y., 1943. 802 pages, illustrated, 9 by 6 inches, cloth, \$6.

The purpose of this book is to give the student a substantial grasp of physical principles rather than to describe phenomena. Material dealing with some of the recent advances in physics and in their applications has been added to the revised edition. These include sections on the fluorescent lamp, the electron microscope, the mesotron, and nuclear fission.

Engineering Drawing. By L. M. Sahag. Ronald Press Company, New York, N. Y., 1942. 394 pages, illustrations, etc., $10^1/_2$ by $6^1/_2$ inches, cloth, \$2.75. (ESL).

The aim of this text is to offer a basic course that will be complete and thorough in subject matter and also closely related to industrial standards and practice. The text is divided into three sections of increasing difficulty, fundamental requirements being taught first. A wide selection of problems is included.

Differential Equations. By R. P. Agnew. McGraw-Hill Book Company, New York, N. Y., London, England, 1942. 341 pages, diagrams, etc., $9^1/_2$ by 6 inches, cloth, \$3. (ESL).

Offers a first course in the subject for those with a working knowledge of algebra, trigonometry, and elementary calculus. It is intended to give a mastery of the techniques by which differential equations are obtained and solved, and by which the solutions are applied.

Alternating-Current Circuits. (Rochester Technical Series.) By E. M. Morecock. Harper and Brothers, New York, N. Y., London, England, 1942. 175 pages, diagrams, etc., $9^1/_2$ by 6 inches, cloth, \$2.75. (ESL).

This text is intended for use in technical institutes, junior colleges, and industrial schools, and is based on a functional study of the essentials of a course in the subject. Problems and laboratory experiments are included. No knowledge of calculus is necessary.

Electrical Counting (with special reference to counting Alpha and Beta Particles). By W. B. Lewis. University Press, Cambridge, England; Macmillan Company, New York, N. Y., 1942. 144 pages, diagrams, etc., 9 by $5^1/_2$ inches, cloth, \$2.50. (ESL).

Describes the technique of this method, which is an essential aid in research in nuclear physics. Much of the text, dealing with amplifiers, oscillograph recording, stabilizers, and circuits will be of interest also to others who use vacuum-tube circuits.

The Man Behind the Flight. By A. Hordanoff. Harper and Brothers, New York, N. Y., 1942. 276 pages, illustrations, etc., 10 by 7 inches, cloth, \$3.50. (ESL).

This book presents some information on mechanical drawing, elementary electricity, hydraulics, mechanics, and physics, accompanied by a brief outline of airplane history. It is offered as a ground course for aviation mechanics and airmen.

Ultraviolet Light and Its Applications. By H. C. Dake, J. De Ment. Chemical Publishing Company, Brooklyn, N. Y., 1942. 209 pages, illustrations, 9 by $5^1/_2$ inches, cloth, \$3.25. (ESL).

Some of the uses to which ultraviolet light has been put in criminology, warfare, advertising, and medicine are described briefly in nontechnical language.

PAMPHLETS . . .

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

Save Fuel for Victory. By members of the engineering faculty of the University of Illinois. The University of Illinois, Urbana, 1942. 35 pages, 25 cents.

Properties and Applications of Phase-Shifted Rectified Sine Waves. By J. Tykocinski Tykociner and Louis R. Bloom. The University of Illinois, Urbana, 1942. 54 pages, 60 cents.

Resuscitation after Electric Shock. By Charles F. Dalziel. University of California Press, Berkeley, 1942. 14 pages. May be purchased in lots of ten or more. Write for prices.

Standards for Carbon Dioxide Fire Extinguishing Systems and Inert Gas for Fire and Explosion Prevention. National Board of Fire Underwriters, New York, N. Y., 1942. 43 pages.